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A SCIENTIFICALLY STABILISED CURRENCY.

Address given to the Institution, London Section, by Dr. Robert Eisler.

THE Chairman, (Mr. W. F. Dormer, Section President) : I am privileged this afternoon to have the honour of introducing to you Dr. Eisler, of Vienna, late Assistant-Director of the League of Nations Universities Inter-relation Office. It may seem somewhat strange to you that we, as production engineers, should be interested in such a subject as "Currency Reform," but as an Institution we are interested in any individual or national scheme which will assist production. Just lately we have heard and read a great deal about the gold standard, rates of exchange, and the dangers of inflation, and therefore we consider ourselves very fortunate indeed in having Dr. Eisler to explain to us his scheme of credit expansion. Without delay, I have now pleasure in calling upon Dr. Eisler.

Dr. Robert Eisler said : Mr. Chairman, Ladies and Gentlemen, it is a very great honour indeed, and an equally great pleasure for me to have been invited to speak before the Institution of Production Engineers on a matter of such vital importance as the organisation of a scientifically stabilised currency for the British Empire, and such countries as would be willing to affiliate themselves through the proposed sterling area. I think that I shall meet with no objection on the part of production engineers if I say that I am firmly convinced that the evils which have been wrought by an antiquated and inherently unstable monetary machinery, and by an inadequately elastic, jerkily expanding, capriciously contracting credit system, cannot be cured except through the introduction of an absolutely freely expansible currency with reasonably stable purchase power. What the world wants is the technical perfection of the only machinery which has not kept pace with the marvels of our technical age—the perfection of a machinery which has recently completely broken down after having caused all through the nineteenth and twentieth centuries—through its antiquated clumsiness and inherent instability—all the mischievous fluctuations of economic activity which experts call the "vagaries" of the trade cycle, not to speak of the intense miseries of the so-called "major" crises rotating all through the nineteenth century every seven, eight or nine years.

The Issues to be Examined.

I shall endeavour to prove to you that the terrible disequilibrium

between producing capacity of the world and the consuming capacity of humanity, which is at the bottom of the actual crisis—as it were, the root evil in all present crises—is essentially a monetary phenomenon caused through nothing so much as through the instability of the price level in terms of unstable money. I shall proceed to show you that the organisation of a stable money system (as distinct from the mere " pegging " of a currency) is not only perfectly possible in theory but easy to achieve in practice, and that, as a matter of fact, such a stable money system would be much easier to administer than the admittedly difficult art of managing a gold bullion standard currency, not to speak of the tricky gold exchange standard system.

I shall show you that under a freely expansive currency system it will be possible completely to re-absorb existing unemployed and to proceed to steady capacity production without any crises for ever after.

I shall explain to you why this scheme at the moment cannot be realized on a world-wide scale owing to the opposition of certain States who are determined on a deflationist policy and radically opposed to any monetary expansion, and I shall show you that the British Empire, together with countries who would be quite willing to affiliate themselves to a sterling area, is sufficiently self-contained, and therefore can at any moment adopt a scientifically rationalised currency system, whatever other nations may want to do at the same time.

I shall finally show you that the adoption of such a currency system would not only be of the greatest economic advantage to the British Empire but would enable you to resume your pre-war political position of towering predominance which we, at least in Central Europe, desire you to resume as quickly as possible. This is not said in order to flatter anyone among my audience, but it is the mere expression of the fact that we cannot go on living under a currency system which is under the direction of a deflationist power, which is under the direction of the monetary administration of the Bank of France. Before the War the world's monetary system was administrated, without anybody knowing it, by the Bank of England, and I can assure you that all of us on the Continent have been living under this system a much happier and a much easier life than we are living now. It never was a gold standard system ; the value of gold was at that time determined by the value of the pound sterling, by the amount of credit and currency built upon a gold foundation by the Bank of England. It became in after-war times a dollar standard, the value of gold being determined not by the production of gold but by the amount of credit and currency built upon this basis by the Federal Reserve Banks of the United States; and it has now become, through the energetic deflationist policy of the Bank of France, a French franc standard system.

You have regained political freedom, but you must now use it to a sound and scientifically correct purpose. This is, if I am not mistaken, the most urgent need of the hour ; it is perhaps the most important problem of our age. I think we are now at one of the most decisive turning points in the economic history of the world.

The Crisis a Result of Monetary Policy.

I shall try to prove to you that the actual disequilibrium, the actual crisis, has mainly monetary causes. I shall not encounter here in England much opposition because public opinion here has been prepared for this thesis through the work of British experts on the League of Nations Financial Committee, especially on the Gold Delegation, through the discussions of the Committee on industry and finance. Nevertheless, I shall say something about the mechanism of this crisis because I am not prepared to attribute all the evils to gold—to assume that gold was the principal villain in the play. I am not prepared to attribute all our present evils to the restoration of the gold standard in England in 1925. I believe that the mechanism was a different one and that the roots of the evil were sown immediately at the beginning of the world war.

It is the succession of monetary inflation and deflation which has caused our present plight. There was a classic school of thought which assumed that there could never be a disequilibrium between production and consumption, that goods would always exchange against goods, and that the more goods you produced the more you could exchange. This is not true in monetary economics. There is (for you as production engineers this will be clear) in our modern industrial system a fundamental factor creating a disequilibrium between producing and consuming capacity of a given society. You know that it is the essence of motory power, the function of machinery, to increase production without increasing labour employed. There was a time when there was only the one biological motor, the arm of a human-being, the only auxiliary machinery being a beast of burden. If an Athenian manufacturer of armaments, in view of an impending war, wanted to double his output of javelins, he could not do anything else but put in twice as many workers, slaves or freemen, as he employed before. He had to pay twice as much wages, or to nourish twice as many slaves. There was a natural harmony and natural proportion between wages paid out and output of a production unit.

You all know that this natural prestabilised harmony does not exist, cannot exist, and must not exist in our modern world ; that you can increase production manifold without increasing and even by diminishing labour employed. We have done so in our Austrian mining industry ; we have increased our output in after-war years, while reducing labour employed to two-thirds. You know that in

America in 1919, which was a so-called boom year, about 8,000,000 men were employed; output was increased more than 130 per cent. until 1928, and labour employed has fallen, before the actual crisis in 1929, to 5,000,000 workers. It is quite clear that through diminishing labour employed and through increasing machinery, growing disequilibrium must be created between producing and consuming capacity. I have seen a very amusing American caricature in which the world, which was represented as a gigantic machine, was holding in its grip the last remaining consumer and carrying a large label "No Help Wanted." It is obvious that in theory you can imagine a world employing no labour whatever, and you can equally easily imagine who would then be able to take the goods which you produce. But this factor creating disequilibrium, you tell me, is a non-monetary factor. I should hesitate to say that, because putting new machinery into a works, or ploughing one single furrow, must be paid for. Technical progress in industrial plant is possible to the extent to which the manufacturer, the owner, the shareholders of the plant are able and prepared to pay for it. This is a monetary phenomenon, and equally so the consuming capacity of the public is nothing else but the amount of cash and credit which the consumer holds at the given moment. If these two floes of money are disproportional this is a monetary factor, and therefore you can assume from the start that such a disproportion is a monetary phenomenon.

The Results of Inflation.

Now we shall go one step further and consider what happens if the monetary system is inflated—then credit becomes super-abundant; there is more credit created than would be offered through the natural savings of the nations of the world as a whole. The cost of this credit is unduly cheapened; it may very rapidly become negative. A man may easily borrow money at six per cent. for one year, and he may make in one month 10 or 12 per cent. profit by repaying his loan in depreciated currency—therefore, he gets a premium for borrowing. Not only does another man's money not cost him anything, but he gets a premium for borrowing. At the same time the cost of labour employed is artificially diminished, is diminished according to an inexorable law, because wages do not rise with the same rapidity as prices. The time lag in England has been estimated at about one year. When credit and labour employed are unduly and disproportionately cheapened a manufacturer naturally feels a fool if he lets his money rest unemployed in a bank, or if he lends it at fixed interest to another man—and even if he were such a fool the other man would take care of his money, therefore, the economic individual producing capacity of the country and of the whole society is disproportionately increased. Even if

a man exports his liquid capital in order to protect its value from an inflationist country into a non-inflationist country, he inflates the currency in this other country, and therefore automatically in an inflationist period the producing capacity of the world is greatly and disproportionately increased.

What happens at the same time to consuming capacity ? This is diminished very quickly because through the rise of the price level people with fixed incomes are partly expropriated ; they cannot buy what they used to buy because of rising prices and, as I said, the real wages of the whole salaried class diminish. These people have less real wages, less purchase power, because a given salary will buy a smaller quantity of consumable goods. Therefore, you say that through a mechanism, through an inexorable monetary law, in a period of inflation a divergent evolution of consuming and producing capacity is started.

The Results of Deflation.

The fundamental mistake of our post-war economics was to believe that this divergent evolution of producing capacity and consuming power would be corrected through deflation after having been started by inflation. Now we have seen a strange thing in our technical age—this does not happen, but exactly the contrary. If a manufacturer is forced to sell his product at a lower price, he can do that if he can proportionately reduce his costs. He can only reduce his costs by further mechanisation and rationalisation of his plant, and by reducing his wages bill. This seems obvious. Therefore, even in a deflation period mechanisation and rationalisation, increasing plant and motor power, goes on. I could prove that, with many diagrams and by analysing many balance sheets. Not only does the mechanisation and rationalisation of industry continue in a deflation period, because the manufacturer can now invest the profits which are left over from the former very favourable period of inflation in new machinery and in new organisation, but even in a deflation period the individual manufacturer will try to increase his output because, as you all know, the more output is increased the more the proportion of overhead charges diminishes, the cheaper he can produce. Each one of the manufacturers will try to take trade away from his competitor by increasing mechanisation and rationalisation and by increasing output. Even in a deflation period the increase of producing capacity goes on. What happens in the meantime to consuming capacity ? It sags away again, because the individual worker gets less wages ; he does not, of course, get the full advantage of the lower price level because retail prices do not fall as quickly as wholesale prices. There is an all-round loss of purchase power.

The main cause of decreasing consuming power in a deflation

period is the fact that, according to a recently developed formula, *in a deflation period unemployment increases in the exact proportion of the falling price level if nominal wages remain stable*—that is to say that the manufacturer tries to reduce his wages bill by putting in new machinery, by replacing labour through machinery and motor power. It is not the individual wage earner who loses purchase power but the wage-earning class as a whole. Five, eight, ten, twelve, fifteen per cent. of all the workers and employees are now stopped, thrown on the pavement; they lose their purchase power, and nothing remains to them but the dole or charity. Therefore, again under deflation the divergent evolution, the disproportion between consuming power and producing power, is increased. You now find yourself at the end of two such successive periods.

You can easily see that the natural tendency of our economics is deflationist. People try by all means to get the equilibrium back by getting rid of this apparently super-abundant producing capacity. Throughout the world there is a tendency to reduce stocks and producing capacity. The situation is absurd to an almost unbelievable extent. In Brazil money has been created through reducing the legal proportion of gold reserve in order to buy up millions of sacks of coffee and to fling them into the ocean. The same has been done in Cuba for sugar and rum. In Hamburg the State has given ten millions to ship-owners in order to break up perfectly good and modern super-abundant tonnage. In Czechoslovakia, State public subventions have been given to textile industries in order to buy up so-called super-abundant power looms and to destroy them. To inflate your system in order to destroy producing capacity is the most absurd process which you possibly could imagine. It is a nightmare to think of these things, and I expect that you, as production engineers, you whose task it is to develop production, will respond when I tell you that this is an intolerable state of affairs and that a system which shows symptoms like these is doomed. If we even leave aside the intellectual or moral side of the question, you will immediately see that this cannot help because you can easily increase production without proportionately increasing labour employed. That is quite possible, but it is obvious that if you reduce production you must reduce in the same proportion labour employed. Reducing production means reducing consumption in the same proportion. The deflationist method of saving ourselves by tightening our belts, by creating misery in one country in order to force down the standard of living in another, means creating misery all round and creating progressive paralysis of all our economic activities. This is intolerable—there is no way out of the situation in that direction.

I shall not take up your time with an historic survey of what were the big inflations and deflations which have led us to the

present situation; a few words will suffice to remind you of what I mean. There was a great inflation all through the war and all through what Winston Churchill has called the "aftermath" of the War; nobody could have financed the War and its aftermath without gigantic inflation. The cost of living was three times what it was in 1913, and there was a universal outcry against the high cost of living. This outcry forced upon you exaggerated deflation, but deflation would have come in any case. Inflation has been caused by the overspending of the Government in times of war and after-war, *and when this happens everyone is forced to overspend because what he saves he loses.* The overspending of the Government naturally came to an end with the Armistice and with the liquidation of the after-war activities in Asia Minor, Russia, etc., and wherever you had minor after-wars. The Government had to begin a period of retrenchment. It was exaggerated through Geddes' Axes and other expedients, and the deflation was accentuated through the banking policy of the country at that time. The rate of interest was raised as soon as the Government did not buy any more, from 3½ to six and seven per cent. Then you were told deflation would be moderate and slow, but there is no moderate and no slow deflation because when you increase the cost of other people's capital to the wholesale dealers who do all their business with other people's capital, you force them to reduce their stocks. This policy of the bank falls on all at the same time, and when they all want to sell to reduce their stocks in a falling market there is no buyer. Therefore prices come down. You had immediately, as the result of the first deflation period, 4,000,000 unemployed in America and 1,750,000 in England. This period of deflation was discontinued in America. I will not talk about the American phenomenon, but here deflation was continued because of the avowed tendency of the State to raise the pound to its pre-war parity with the dollar. Announcing to everyone that you intend to revalorise the monetary unit of the country is equivalent to saying to each one of the manufacturers, "You had better retire as far as possible from business; you will make money if you do not do anything; spend your time in the South of France or in Japan; you will lose money if you manufacture and if you produce." As a result of announcing beforehand that the monetary policy of the country will be directed towards a revalorisation, and by telling people the aim of this policy, you encourage speculation against the man who produces the goods. The result was as could be anticipated—the return to the gold standard was a last effort of contraction of credit; the monetary unit was revalorised in the weeks preceding the restoration of the gold standard by 10 per cent.

When purchase power of gold itself was rising because other countries also returned to the gold standard or prepared an increase

of their gold reserves, the Scandinavian countries, following in the wake of England's and America's monetary policy, had also to restrict; they also created continually increasing unemployment in direct proportion to the sagging of the price level, and thus it went on.

To Create Consuming Capacity is the Main Problem.

What interests you as practical men is how can we get out of this situation? It seems to me most obvious that if we cannot restore equilibrium by destroying part of our producing capacity it is equally obvious that we must try artificially to recreate consuming power to support producing capacity. If we can do that all this dead paralysed wealth will again become real producing wealth; industry will again become profitable, and at the same time you will see unemployment disappear. This is the whole problem. Can we recreate the consuming capacity which we have lost through wrong monetary policy, through the inherent instability of our actual monetary and credit system? *There is absolutely no other economic problem at the present epoch.*

Ordinary Inflation.

You will think this seems very easy—creating artificial purchase power; for this we have a most current ordinary name—inflation. But that is not so. You will see that if the currency is inflated the phenomenon happens which I explained at the beginning, that is to say, that persons with fixed monetary incomes lose a part of their purchase power, not exactly as much as is added to the people who were unemployed and who then become fully employed workers, but they lose a large part of their purchase power; therefore, it is not an addition of purchase power to that class of the community but a transfer from one class to another. That is what must not happen, not because of moral reasons, for I leave the moral aspect of the question entirely aside—this is a technical problem—but because this transfer of purchase power means that we have not added to the total purchase power of the community, at least, not added as much as we wanted to do. Actually this inflation does not add to the purchase power but diminishes the purchase power of the community.

At the end of the astronomical inflation in Germany the total value of the German currency (which could only be expressed in astronomical light years) was equivalent to 500,000,000 Swiss francs for a population of 60,000,000 inhabitants. Not only do we not add to the purchase power of a community by inflation, but after a slight initial addition we take away from the existing purchase power. The fact is that if we double the circulation we diminish the purchase power, but not by one-half, so that in the beginning we can add a little sum to the purchase power of the community.

You must bear that in mind, otherwise the defenders of inflation would come up against me and say what is perfectly true, *that the whole economic advance of humanity has been made in the initial periods of inflation.* Inflation has been going on all through history to a certain extent—witness the fact that Falstaff drank sack for ⅜d. which you cannot do nowadays. It is true that in the initial state inflation could produce a certain alleviation of the situation, but after a very short period you would have the crisis back again; the consumer would be unable to take away from the market the goods which you would newly produce. Through inflation you would only have again increased, after a while, the existing disequilibrium. You could easily under inflation add purchase power to the community, but the purchase power, the consuming capacity would, after having risen to that extent, fall back, and the next crisis would be more vehement and more lasting than what you had before.

The question is, therefore, can you add to the purchase power of those who have too little without taking away any purchase power from others? That is the whole point. Is it possible really to add purchase power, really to expand the value of your currency in our modern epoch? I believe this is possible. We can have all the advantages of inflation without having the disadvantages of such an unscientific, crude monetary expansion as has been practised many times in history.

An ordinary inflation has disadvantages which you can count upon your fingers. First of all, if a country, say England, were to inflate, its Foreign Exchange falls; if this falls the country is forced to export too much and it gets too little in return, even for exaggerated imports, and after a certain time what you get for your exports is insufficient to pay for your imports, always supposing that the other countries are not equally inflating; that, of course, changes the situation, and actually your imports, for example, are cheapened by the fact that other countries have a sagging price level. If they had a stable price level you would already feel a certain rise in the interior price level; you would find difficulty in paying for your imports by your exports. As a matter of fact the phenomenon is amply proved by Germany's experience. In 1923, when they were losing their economic substance, a book of mine which would have cost £2 to produce in England was then sold for a farthing—a million of marks. It is obvious that you cannot replace raw material and the labour invested in any product if you sell it below cost price. In the interior of each country the same thing happens. The man who has sold a commodity, the man who has given his labour, and the man who has lent capital—they are all repaid in depreciated currency; they all lose, and finally the State loses because it gets its taxes in depreciated currency.

Inflation Dangers Can be Avoided; Stabilised Exchanges.

It is obvious that these factors make it impossible to go on with an inflationist currency in the long run. I think, however, it is easy to avoid the dangers. The sagging of the exchange, the disequilibrium between the monetary value of your currency at home and abroad, can be avoided by a process which is commonly known in banking circles under the name of "pegging the exchanges." The technique of doing this is perfectly well known: the thing has been done on a large scale. You remember that during the War the exchanges were "pegged" between England and the United States, the pound was "pegged" in its relation to the dollar; the French franc was "pegged" in its relation to the British pound, and the Italian lira was "pegged" in relation to the French franc. All this was done by a unilateral use of credit. United States trade was all flowing one way: they were producing ammunition and eatables on the other side of the ocean and you were consuming them all during the war. This created a unilateral debt, constituting the War Debt which you are now expected to pay to the United States.

This is not necessary if now all countries participating in the proposed monetary union were to start on a common peaceful crusade against trade depression and unemployment. If they were to expand, *pari passu*, a proportion of their economic activities, it is obvious that no unilateral debt would result from such an agreement. *We want, not unilateral stabilised credits but mutual credits, just sufficient to prevent speculation against the one or the other currency*—mutual credit, so that if you wanted to "peg" the exchange between the Swedish krone and the British pound it would be quite sufficient if the Bank of England granted, with a stroke of the fountain-pen, a credit of £50,000,000 to the Bank of Sweden, and that the Bank of Sweden, reciprocating this generous but very cheap action by an equally generous action, granted you exactly the same amount in kronen. These credits would be fixed at a given figure because a banker will never sign unlimited credit; they could be fixed, say, at the monetary value of imports plus exports, that is, the monetary value of all your trade relations as shown by the returns for one year. If these were granted, as long as they would last, the exchange between kronen and pounds would be absolutely "pegged." If one had more kronen than pounds are required, kronen would be given out of that credit, and if the reverse happened on another day the process would be reversed.

But it is clear that this can only go on in the long run without exhausting either on the one side or on the other one of these mutual credits if you can equilibrate the economic activity of these countries. That, again, is not an insolvable problem. You have now budgets in each country, and private spending is to a large extent governed

by public spending; therefore, if you double public spending, or if you halve it, you raise or lower private spending. This shows how absurd it is to try to get out of our present difficulties by contracting our public expenses. Everywhere, in each country, we have now a budgetary deficit; in my country our budget is contracted, compressed, under international control to the extent the authorities think necessary in order to keep the value of our money stable in its relation with the value of equally energetically contracted French currency. The same effect of stabilising relations between two currencies can be achieved in a much more pleasant and easy way, by expanding them synchronically and proportionally. While in one way you create continual misery, competing in the creation of misery between yourselves, in the other way you create wealth and consumption by expanding expenditure synchronically and proportionally.

Public Spending Essential.

It is nothing but public spending in the different countries which can overcome the actual state of paralysis. Private manufacturers and private enterprises cannot be expected to expand in a moment when no purchase power is facing their producing capacity, when all the markets are glutted, and when all their stocks are overflowing; private enterprise cannot then be expected to increase its activities. It is the State, it is public buying and building, which must break the ice. Therefore it is very simple to establish a contract between the various countries coming into such a system; they would contract with each other to spend next year, say, double the amount they have been spending this year without increasing taxation, indeed, if possible while diminishing existing taxation. You have everywhere a deficit in the ordinary budget; you would simply, to facilitate book-keeping, add an additional supplementary budget in each state. This budget would have to be large enough first to cancel out the deficit. That certainly is not an inflationist process, because it would enable you to spend next year what you spent last year, and since the spending of last year was not sufficient to prevent the sagging of the price level, this spending would certainly not be able to raise it—it would let the price level sag further; it would correct existing deflation to an extent, but not re-inflate the monetary circulation. The additional budget must be large enough to leave a large margin for new public buying and building.

Stability of the Interior Price Level.

It is possible to maintain continally the stability of the exchanges by means of mutual credit and by means of treaties about proportional spending—additional spending without new taxation. You will say that this is most obviously a concerted proportional system

of international parallel inflation, and in the interior of each country we shall see the most characteristic phenomena of each inflation, the rising of the interior price level, and we shall have what we have at all costs to avoid—rising prices and lagging incomes—incomes lagging behind the rise of the price level, and therefore, the incapacity of the public to buy the newly produced goods. *We must, therefore, have not only stability of the exchanges but also reasonable stability of the interior price level.* Could we keep the interior price level steady during a monetary expansion ?

The Plan.

Here again we are at the centre of the whole problem. The thing can be done. The technique is nothing new ; it was invented by English settlers overseas in 1747. You would have nothing to do but to decree in a short new monetary law that the monetary unit of the British Empire and of the countries wanting to affiliate themselves to that sterling area would be the British pound—the English bank note which was equivalent at the 18th September, 1931, to so-and-so many grains of fine gold—and *you would decree that this bank note, this current money, is legal tender to the extent of its actual purchase power on the day of payment.* That is all.

The actual purchase power on the day of payment is measured as the reciprocal value of the cost of living index on that day, the cost of living index being defined as the average price of, say, a basketful of commodities which make up the weekly consumption of an average household, including rent, rates, taxes, local transport, and, if you want, elementary education fees. If you did that you would see a curious thing : under this law each wage-earner would have index wages and index salaries—that is a thing which is familiar to you because you have it in certain sheltered trades and in certain sections of the Civil Service—but not only the wage-earners would have index wages and salaries but each creditor would own an index capital and have a right to index revenues, that is, a man putting into the bank to-day £1,000 ordinary current money (notes) at to-day's normal index of 100 will have a deposit of £1,000 banks money.

The distinction between current money and banks money was in vogue all through the 17th and 18th centuries. At that time the current money of the state was constantly depreciated by certain gentlemen adding copper to silver and creating a money out of most impure bullion. Therefore the merchants of Hamburg protected themselves by depositing that depreciated money in a bank and being credited with so much banks money.

Suppose this happens to-day. Next Friday we shall be able, through our most generous new credit creation, to begin work on,

say, Charing Cross Bridge. We shall spend thousands of newly created pounds current money in the form of wages to people who have hitherto been unemployed. That money would be paid out on Friday evening, and on Saturday morning the men's wives would go to the market and buy all their household requirements ; naturally through that increased spending power prices on the market will go up, and they will go up very fast and very much because people, knowing what inflation is, and dreading that this is no ordinary inflation, will say " Things will be still dearer on Monday and Tuesday, so I will buy whatever I can." They will hoard commodities instead of doing what they do now, hoard money.

We shall suppose a most terrific rise in the price level, and we shall call the new price level 130. Your £1,000 banks money at the index of 133 would be equivalent to £1,333 current ; the bank to whom you have confined your savings owes you £1,333 if you want to take out your money in notes. You may ask where the bank is going to get that money, but do not forget that the bank is not sitting on the money which you have deposited there, not brooding on it ; it lends it out to its customers. Even the money which the bank has not lent out would not be depreciated ; they would simply deposit it with the Bank of England and that Bank, being the source of credit creation, cannot lose by giving back to the private bank, having deposited cash when the index was 100, £1,333 for a thousand deposited. This sounds curious, but for people who are conversant with mathematics it is quite clear that only under such a system are contracts equitable over a long period—under our actual system the creditor is continually swindling the debtor or the debtor is swindling the creditor. A man having borrowed a thousand pounds and paying them back after a time is always nowadays either swindled or swindling.

Not a Double Currency.

I am frequently accused of wanting to introduce a double currency, which is nonsense, because, according to Gresham's Law, two currencies cannot circulate ; the worse will always drive out the better. *This pound banks is not a currency at all, it does not exist ; it is nothing but a measure, an instrument of accountancy. Therefore under this system you can expand it without taking away purchase power ; you do not effect any transfer from one class to the other, or from one individual to another.*

The trick is done—that is to say, our workers' wages and employees' salaries, or the interest which any creditor receives from his debtors, are absolutely stabilised in terms of such goods as are essential for the household of an average family in retail prices of these commodities, but you will see that this is not yet a complete stabilisation.

Stabilising Wholesale Prices.

It is not sufficient for you as manufacturers to know that your money is stable in the returns of retail prices of the commodities which are essential for the household of an average family ; *your money must also be stable in the wholesale price of production goods ;* it must be stable in terms of the prices which you pay for the raw materials and for the energy which you buy, and stable in the money which you get for the produce which you sell. That can only be achieved by managing the total volume of existing banks money by the ordinary recognised means of banking policy with regard to the wholesale price level. The Central Bank must raise its rate of interest, or lower it ; it must sell securities and by selling securities take bank money out of the money market, or by buying securities infuse bank money to the market so as to keep the wholesale price of production goods—of all goods as a matter of fact—as stable as possible. It has been shown that it was possible to keep the wholesale price level of goods as stable as that all through the years 1923-28. It is perfectly clear that the central banking policy can achieve this end ; if it does, you will have a stable money system ; you will be able to expand your currency according to the wants of production and consumption, and keep the purchase power of the monetary unit absolutely stable as well in those terms that matter to the consumer, that is, the retail price of consumption goods, as well as the whole in terms of the wholesale price of producing goods. *Under such a system it will always be possible to have full employment and capacity production.*

After you finish a very large undertaking it is not only on this undertaking that employment ceases, but in all the industries which minister to a given extent to this undertaking. Therefore private economic activity cannot be stable ; it must always oscillate. The state has always been called upon to make good these fluctuations, and under a freely expansible currency system, under a stable money system, the State can always (of course, in connection with other nations taking part in the same system) create the necessary amount of credit in currency so as to compensate the fluctuations of private activity by public buying and building.

Conclusion.

If there is no unemployment the real wages of the whole salaried class must continually go up, because each new undertaking will be forced to take its labour out of another man's plant by offering higher wages. There is no other possibility. At the same time the the profit of the enterprise, the profit of the manufacturer, will constantly increase because through capacity production he will at last be able to reap the full profit of technical progress and the

increasing productivity of his machinery, and at the same time the Civil Servant, the annuitant, and other people in possession of savings of contractual incomes will, in terms of the commodities necessary for their life, have always the same amount. You will have a constant increase of consuming capacity exactly to the extent to which it is necessary constantly to take away from the markets the goods as rapidly as you produce them.

This is the solution of the main problem of the technical age. You can do it. The British Empire, together with Latin America, Scandinavia, Portugal, Spain, and all the other countries who have been driven from the gold standard, is a sufficient area ; it is self-sufficient enough not to need imports from the outward world You can do it. You must do it. (Loud applause).

Discussion.

Mr. A. A. KEEVES : This able address has been given without a single note and in beautiful English—it is a marvellous performance. I cannot criticize Dr. Eisler's address, but Currency Reform is a subject to which I have given much thought, and, summing it up as a layman, I think the problem is made complicated through the want of one thing. If the world, leaving the water out, were one big country, I venture to say that there would be one system the whole world over. It is our policy of wanting separate nationhood—the English man wants to get rich in England, the German in Germany, and so on—that creates the difficulty, and unfortunately, there are varying policies of currency and other matters which govern those nations and eventually throw them out of joint.

The lecture to which we have listened ought to make us all think and make us anxious to study the lecturer's books. Currency Reform looks such a complex subject, but I venture to think from its complexity Dr. Eisler has reduced it to simplicity. It is a wonderful subject, and I do wish our countrymen and our bankers would get down to the bedrock of this question. After all, in this country of ours we have been pioneers in many wonderful things that have gone to benefit mankind.

Professor JEVONS : I would like to add my tribute to that of the previous speaker for the extraordinarily clear exposition we have had from Dr. Eisler ; I have never heard this subject put so clearly within the space of an hour. I think he was not altogether fair to the inflationary party, if I may so call them—those economists who are for inflation (the majority of them would call it " controlled inflation "). I think that they seek a stabilisation of the price level through an inflation when prices are tending to fall and a deflation when prices are rising. It is believed by many (and I do not know that Dr. Eisler could altogether contradict it) that there are external causes all over the world simultaneously which do necessarily affect price levels and that these simply have to be observed and the effects of them corrected. We believe that by the mutual credit arrangement which Dr. Eisler well described and by the Government undertaking expenditure where necessary—if all this could be co-ordinated between a large group of countries without leaving out any of the large commercial countries you would achieve a relative stabilisation of the price level. The people must be tought exactly how the system will work ; we must know the exact details before anybody in this country will advocate its adoption.

Mr. G. BIDDULPH : I should like to associate myself with Professor Jevons and the first speaker in congratulating Dr. Eisler on his extremely lucid and interesting address. The one criticism I should

make is that I do not see the necessity for the tabular standard if you have controlled management of the level of primary products. Why does Dr. Eisler see the necessity for both standards ?

Dr. EISLER : There is of course an inflationist element in the system which cannot be avoided but by making it as difficult as possible to raise the price level, and that, of course, can only be effected by banking policy. We shall have a transition period. We begin now to talk about this thing, but suppose the Chancellor of the Exchequer took up the subject and told you that monetary expansion was possible and the Cabinet was contemplating it—you would see a very curious situation on the commodity market. A cable manufacturer does not buy copper, but he sells the same or double the amount of copper : he hedges. Therefore he has effectively no copper stock, no raw material ; he owes copper stock. The price of copper will soar. In that period the Bank of England would simply have to raise its Bank Rate and to make an open market policy so as to prevent speculators from raising the price of production goods to any extent.

It is obvious that the system which I am proposing to you is not an automatic system in any sense. It is to a degree, of course, an inflationist system, but the whole thing which we want and which we must have is control in inflation. I am in agreement with the School of Controlled Inflationists although I am not a Socialist but, as you will see, an ultra-Conservative. The beneficial period of inflation is in the beginning : in our uncontrolled currency system you get the lasting benefits of inflation during that period, and then you have a stable money system, but you can have it only for a limited period. If the whole monetary system is progressive, then you get, with many set-backs, a certain economic progress : if the basis is decreasing, then you get the contrary ; you get long drawn out crises, and small alleviations of the situation by means of credit manipulation. We have all been poor and I do not know whether anyone here has ever had enough in all his life of all the goods. I certainly have not. Now I would ask what it is which has caused that limit, that check on production and consumption ? There is no physical limit to production : we have unlimited stores of energy and unlimited stores of raw materials, and we have always a surplus of labour because machinery constantly displaces labour. The age of scarcity is as dead as the Stone Age and the engineer has brought about the age of plenty. What in the age of plenty limits production and consumption and perpetuates poverty which has become a paradox in the technical age ? It is nothing but the monetary system which forces you after an advance of four steps in the initial periodof inflation to retract your steps always after having created a certain amount of wealth.

Replying to Mr. Biddulph. The tabular standard would not be

necessary under a managed currency if we could begin with our actual price level, but we have to raise the price level without inflicting hardships on those who profit now and who are now protected to a certain extent through the very low retail price level. The retail price level would now immediately respond to any rise of the wholesale level because nobody has stocks. The wholesaler has limited his stocks to the lowest possible extent, and the retailer has done likewise. Therefore, the purchase power of the men with fixed monetary incomes will now fall very quickly. The system I advocate is freely expansive, which makes it possible to go from one level to the other without difficulty. Any amount of rapid increase of production and consumption is possible under this system without creating hardship, and it is impossible under the actual system. If you want to reinstate the unemployed you must pass from one price level to a higher one, and that cannot be done without inflicting hardship on a large class of the population. Therefore you cannot do it. With regard to calling monetary stabilisation "veiled inflation." You are right, but it is no objection against veiled inflation. We must have slow inflation; it is the only possible way of passing from one price level to the other. There need not be any unemployment, and there is no poverty in the industrial world but the unemployed and the unemployable.

MR. T. G. ROSE asked what first steps would be necessary if the Prime Minister wanted Dr. Eisler to start his scheme working.

DR. EISLER: The first step is the convening of an Imperial Monetary Conference—a proposition which means starting discussion on intelligent terms. Convene a Monetary Conference of the Dominions, and the Currency Boards of the various countries who are to represent any country desirous of joining in that Monetary Conference could send a representative. You would have them here within a week—that I could guarantee. There are countries waiting for the moment when they may send a representative here to a monetary conference which would make it possible for them to finance their own undertakings. It would be a conference very different from the Disarmament Conference because each one coming here would like to have things done as soon and as quickly as possible. Each country would send you a Finance Minister, accompanied by the President of the National Bank, accompanied above all by some expert calling himself a Monetary Technician: (there are no such people). They would all meet here and discuss the question, and that would be the first immediate step to take. They would be willing to agree on moderate stabilisation credits, and that would have the great advantage for you of thawing all the frozen credits, all the money which you have outstanding in South Africa, in Australia, and in Brazil; all this would be recreated and thawed in a fortnight, and the money acting again. The first

step is definitely a conference. After the conferors have come to an agreement (that could happen within a month) then would come the necessary legislation in the British Parliament, and all the other Parliaments. The public, of course, will never understand anything about monetary matters—that must be agreed upon. It will be a matter for engineers, for mathematicians, and for technicians, but the thing can be put over by the Governments in collation with the press.

MR. R. H. HUTCHINSON : As the lecture proceeded I found myself beginning to suffer from a little mental indigestion, and wondering whether it was not too big a claim that this new system was going to do away with world crises for ever and aye, but the way in which Dr. Eisler has answered the questions this afternoon, the human touch, that touch of wit, and the fluent way in which he has taught us Englishmen to use our own language, has brought me almost to a normal state. I have really derived an enormous amount of benefit from this talk, and when you find yourself at the end of proceedings on a Saturday afternoon wishing that the time was not getting so short, the fare must have been extraordinarily good. Therefore, it gives me the greatest pleasure to propose a very hearty vote of thanks to Dr. Eisler. I have proposed a similar vote of thanks in this room on many occasions to famous lecturers, but I can say that never have we had the pleasure of the illumination of such a wonderfully concise address from one who is so obviously a master of his subject.

MR. N. WILDE : As a paper scheme it is the most perfect scheme for stabilising prices I have ever encountered. The real problem is to transfer it from paper to action. I have great pleasure in seconding Mr. Hutchinson's vote of thanks to Dr. Eisler.

The vote of thanks was adopted with enthusiasm, and the meeting concluded.

EIGHTH ANNUAL DINNER OF THE INSTITUTION

THE eighth annual dinner of the Institution was held at the Grand Hotel, Birmingham, on Saturday, October 31st, 1931. The attendance numbered nearly two hundred. Sir Herbert Austin, K.B.E. (President), was in the chair.

The toast of " His Majesty the King " was duly honoured.

The President said it was not his intention to give anything in the nature of a presidential address ; he preferred, rather, to speak to them on a few points in quite an informal way. He was deeply sensible, he said, of the honour the Institution had conferred upon him in electing him President for the current year, and he could assure them that he would do all he could to promote the best interests of the Institution. When he joined them on a former occasion at a banquet, he expressed the fear that there were far too many institutions, and advanced the opinion that more effective results might be achieved if the various engineering and kindred associations merged together than would be possible if they remained as separate units. He was happy to say, however, after seeing the progress made by the Institution of Production Engineers that he thought it had thoroughly justified its inception and was going to become one of the most successful engineering institutions in the country. There was no doubt that the production engineer was going to be a very necessary factor in future manufacture. The name " production engineer " was, he supposed, in the first place, associated very largely with American practice. He did not know who originated the term, and, quite frankly, he had never been able fully to appreciate exactly what a production engineer was except so far as his limitations were concerned (Laughter). So far as his experience went, in a works which flattered itself on being a modern concern, he was still at a loss to know as to how far a production engineer might go or might not go. He was quite sure that if they were to ask the designs branch of one of our great engineering works what they thought about the production engineering side they would say that the latter was always ready to declare how they would make a design whatever the product was, and that the production engineers in many cases would hold the opinion that they could make a better job of it than the designers. (Laughter). He was equally sure that both the designs department and the sales department very frequently held the view that they could make a job as good as, if not better than, the production engineers. (Laughter). He congratulated the Institution of Production Engineers on the progress it had made. Already it had justified its

existence, and it appeared to him that in the comparatively near future it might be able to do a very useful work on the technical engineering side, not only amongst their members but in the education of graduates. In that respect, the Institution might become as important as, if not more important than, several of the older institutions. It seemed to him that it would be a very good thing if they could conveniently, and without too much delay, lay down the limitations or the necessary activities of the production engineer. He thought that would be rather a good thing for the Institution itself in that it might conduce to the more active assistance of some other institutions who might think that the production engineer was perhaps carrying on under conditions which did not quite conform with modern manufacturing ideas. It might be worth while, therefore, if they could agree upon what a production engineer should be and should not be. A useful purpose might be served by the preparation of a paper upon this subject, and then, by due consideration of it, it might be possible to arrive at some solution of this knotty problem. The old-fashioned general manager had to face few of the present day difficulties. He was put in general charge and he had a few men who he thought would get him through his work satisfactorily. That type of general manager would be out of place to-day, for it would be quite impossible for any one man, however capable and efficient, satisfactorily to discharge the many varied requirements of a great modern industrial undertaking employing from 10,000 to 15,000 workpeople. In such a concern it was necessary that posts such as those of sales-manager, production engineer, designer, research engineer and several other positions, should be held by important men. It seemed to him that production engineering was becoming a definite department of manufacture and that, sooner or later, it would be an advantage to specify exactly what were the functions of that department, what the members of that institution would themselves consider the position they had a right to occupy, and what their relationship should be, in a technical sense, with other members of the staff. It was of the highest importance that there should be the closest and the most friendly co-operation between the production engineer, the designer and the sales manager. Successful contact between these members of the staff did not merely mean personal contact—essential as that was in their own particular works—but it meant their keeping in touch as an Institution with the other institutions that controlled the destinies of the designers or the salesmen and discussing with them each others' difficulties. We were becoming more specialised every year, and it was a great advantage to specialise in a particular branch of engineering. The work of the production engineer opened up a big future for some of the clearest and most competent brains in the country, and he wished the Institution and its members every

success. The different positions he had mentioned in a large industrial concern had definite functions. The one must not interfere with the other, but the one could often be of real service to the other in the way of suggestions, and he could not help feeling that the degree of success obtained by the production engineer would be largely in proportion to his satisfactory contact with other branches of the business. The point they had to bear in mind was that if they were to make progress, constant changes were necessary. Progress would be much slower if limitations were to be placed upon the designer. He must have a certain amount of freedom, and the work of the production engineer was to produce on the lines put forward. It was also necessary to consider the mentality of the public. There were changing tastes and fashions. Peoples' ideas changed about motor cars just as they changed about the style of the clothes they wore. Therefore, it was up to the man in charge of the designing department to supply what the public wanted—not on his own, because it was essential that he should confer with the sales manager to see precisely what the public required, and, next, with the production engineer as to the best methods of producing what was necessary. The points to be aimed at were first to see what the public wanted and next to make the product as well and as cheaply as possible. But such efficiency and such economy could not be obtained without that kind of contact between the staff men he had mentioned. His own personal view was that in many industrial concerns the production engineer should control the purchases. All production engineers were not equally capable, and some might need the services of capable buyers, but for practical reasons the buyer ought to be under the direction of the production engineer. That was putting up another problem to the production engineer, for it meant that it was going to bring him perhaps as much into the domain of commerce as of technique. If he quoted a few figures concerning the needs of the firm with which he was connected he thought they would appreciate that the production engineer must have some means of controlling the operations of the buying offices. It was all very well for the buyer to push into their stores 100 pieces or 1,000 pieces of a particular part and only a very limited number of other pieces. Practical difficulties of that kind arose, and it seemed that it might become necessary for the efficient production engineer to have some training in these matters, for he might have to become as much a commercial man as a purely technical engineer. He must be thoroughly familiar with the subject of storekeeping. At Longbridge they had five types of chasis, four types of bodies, four different colours for cars and three distinct kinds of trimmings. So that in the aggregate there were 240 different combinations. The production engineer, if he was merely a mechanic, could not deal satisfactorily with such

matters. Let them take, he said, the subject of component parts. The average number per model was 2,200, and the number of parts handled per week at Longbridge was approximately five millions. Of this number about 2½ million parts were bought finished, and a similar number were made at the works, so that if they multiplied by eight as representing the average operations on the parts made there, they got a total figure of 20 millions, to which they had to add the 2½ millions of finished parts, thus making the total handlings per week of 22½ millions. Then again, on the question of material as distinct from fuel the weight received per week was 2,000 tons, approximately 1,000 tons by rail and 1,000 tons by road, but the time might come when the percentage of material carried on the road would be 95 per cent., and on the railways five per cent. Sir Herbert expressed the view that institutions such as their's should be self-supporting and said he was glad to hear that it intended to fight its own way and not depend on assistance from outside sources. That was an ideal that ought to be kept in view. With the membership of the Institution increasing—he believed they would have 1,000 members before long—he expressed the hope that the Institution would see that the quality of the membership was kept as high as possible. Quality was much to be preferred to quantity; numbers would come later when it was realised that it was worth while to join the Institution, in that membership carried with it a recommendation that could not be obtained in any other way.

Dr. H. Schofield, head of Loughborough Engineering College, proposed the toast of "The Institution." He thought that even the most casual observer would realise that we were coming into a period when industrial organisation would be the most important, if not the governing, factor of community life. There was an increasing tendency to-day—quite different from what prevailed previously—to ask that business men should take control of the community and govern it as though it were a business. He had travelled fairly widely in recent years, and he could say that it was realised more and more that the running of great countries, which depended for their well-being largely on industrial interests must be directed primarily by business men. He was not going to start an argument on the subject of production, but in his view production engineers could take comfort from the fact that the world was a long way to-day from being in a condition of over-production. We were a long way from what was called saturation point. In certain areas there might appear to be over-production, but, on the other hand, there were huge areas which were simply hungering for the goods which were made, so that the problem was really not one of over-production but of faulty and inadequate distribution. He was not sure that we were not coming to the stage when we should

start at the economic cost of an article—the cost at which it should be given to the consumer, and then make it the business of the production engineer to discover how to manufacture it at that price. They might regard that as a rather revolutionary suggestion, but he felt that there was a good deal of business philosophy behind it.

With regard to the subject of technical training in a College he agreed fully that people in his position could generally take only one half of the responsibility for the training that was necessary. The other half must be left to others in the position of the production engineers to give if they would. He thought it was not unreasonable to hope that they in the works would co-operate in completing the training which they had initiated in the College. He believed that if they would regard the output of the Colleges in that way there would be less friction between the educational side and the production side. The young men they turned out from the College were partially trained, but they were certainly well prepared to receive the advanced stage of the training it was necessary they should have.

He wished their Institution success, and speaking as a member of one or two of the older Institutions, he thought there was a real function which the Institution of Production Engineers could fulfil. It had the advantages of youth and courage and the opportunity was afforded to it to contribute something that would be really helpful. It seemed to him they would do well to develop in their meetings an atmosphere which would give encouragement to the younger members to express their opinions on points of practical interest which had come under their notice in the works. Such members should not have the fear that if they gave their views they might be suppressed by those who had had a wider experience in production work. He pleaded, therefore, for the creation of what he would call an educative forum which would provide fully for the intercourse and exchange of ideas. Many a man had learnt more in trying to teach others than in any other way. They, at the Loughborough College, were invited to co-operate with the examiners of the Institution. They welcomed that invitation and were glad to be of assistance to them. It would afford them pleasure to help in the framing of the examination syllabus, in the conduct of the examinations and in the training of young people for those examinations. Two years ago he expressed the view that the production engineer had a great scope and a big field to cover. Their president had outlined the kind of man who might be described truly as a production engineer, and had emphasised that in addition to a first class technical training he should have a wide human and economic experience. He needed to understand the characteristics of human material, its mentality, psychology, as well as its commercial ability. They might ask :

EIGHTH ANNUAL DINNER [*Reprinted by kind permission of "Machinery."*

could the Technical Colleges help? His reply was that they both could and would. The Colleges would have to be prepared to throw off some of their traditional methods and get down to the problem and help industry as it is to-day. The Colleges would be prepared to do that, for they now certainly realised that the orientation of modern industry had considerably changed. He coupled with the toast the name of Mr. L. H. Pomeroy.

Mr. L. H. POMEROY, in responding to the toast on behalf of the Institution, said he fully agreed as to the need for co-operation between the designers and the production engineers, and in his experience he had not noticed any antagonism. Effective co-operation between the various interests of a works administration was essential; and it was necessary that proper consideration should be given by the designers and the production engineers to the suggestions of the salesmen, because it was the business of the latter to see two years ahead as to what the requirements of the public were likely to be. Whatever might be the changes in taste and style, high quality was essential, and regarding this the public could not be deluded. It was up to the production engineer to see that the quality of the workmanship was satisfactory. We were at the beginning of what he trusted was a new era in industrial England, when the responsibility of engineers in general, and of production engineers in particular, weighed more heavily upon them than ever before. It behoved all to take a note of this fact. There would be greater opportunities for responsible and resourceful men, and it appeared to him that the position of the production engineer would call for more specialisation. He had to face the realities of the job and not to be deluded by formulas. His hope was that the Institution of Production Engineers would continue to progress, and would become a mighty influence in British industry. It was tending in that direction, and it needed to be critical all the time.

The toast "Our Guests" was submitted by Mr. E. C. GORDON ENGLAND, who said they much appreciated the attendance of so many gentlemen who represented important interests in industry. Their opinions were of immense strength to their organisation. They had been told that evening that the production engineer in producing must be careful not to interfere with sales, and he thought that was perfectly right. Close alliance with the salesmen was absolutely necessary. It was sometimes suggested that Production was a modern thing, yet the fact was that the basic methods of production were used by the Chinese 3,000 years ago. They, as production engineers, were therefore not young in thought; the world had lost its way, and great thoughts had to be re-discovered. The work of their Institution was to re-discover those. They had to sow the seeds of propaganda, and these, later on, would bear

fruit. The value of the interchange of ideas in modern industrialism could not be exaggerated.

Mr. E. M. C. INSTONE, replying to the toast, congratulated the Institution upon so much evidence of virility. It had youth and ideas, and seemed destined to play an important part in modern industry. The production engineer had a well assigned and important place and so had the salesman who had to produce the customer, so it was apparent how great was the extent to which the work of the one affected the other.

Mr. Tom Thornycroft then presented the Thornycroft prize to Mr. Henry Mantell for the best paper contributed by a member on the relative merits of production methods in this and other countries. He regretted that the competition had not made a stronger appeal among the members, but the winning contribution had upheld his opinion—despite views to the contrary he had often heard—that this country was not behind other countries in production methods. Ours was the finest Empire in the world, but there were some persons who had been inclined to belittle it as well as our own country. We had now agreed to pull together with the government, and it was also of the first importance that we should pull together for the re-establishment of national industry. We were not down and out, and we intended to show to the world that all that British tradition meant was fully maintained.

Mr. R. H. HUTCHINSON proposed the toast of "The Birmingham Section," and mentioned, at the outset, that the late President of that Section had recently lost his wife. It would, he thought, be appropriate for them to express to him their sincere sympathy in his loss and their appreciation, too, of the work he had done for the Birmingham Section (Hear, hear). He appreciated the importance of joint meetings with kindred societies, and acknowledged the co-operation of the Wolverhampton Engineering Society. In Glasgow there had been formed a committee composed of representatives of various institutions. They had ideals in common and had drawn up a joint syllabus, and had arranged that members of any one Society could attend the meetings of the other Societies. He thought that sort of thing typified what was in the minds of production engineers, for they realised that work could only be successful provided there was co-operation in all branches of the industry. As production engineers they looked upon their position as one covering the whole field of production—from the production of the raw material to the delivery of the finished product, be it a battleship, or a motor car or a sewing needle. Their Institution was not an Institution purely for those people who held titular positions in a factory, but was for those people who were connected with technical and executive positions in the whole field of production. For this reason they felt that ultimately they would become

one of the great engineering institutions—ranking with the Civil Engineers, the Mechanical Engineers and the Electrical Engineers. It was necessary to be borne in mind that the Institution of Production Engineers covered every branch of the Engineering industry. Their three great responsibilities were: To improve quality and finish without increase of cost; by this, greater efficiency and economy to aid the salesmen by reducing the cost of the product; and by the development of research processes and the perfecting of machinery to open a new field for the advancement of the designer. He would thus be enabled to design with greater ease and so create wider markets. Those were their ideals, and he hoped they would be always kept in front of them. The production engineer had a great responsibility because he had to deliver the goods to time and within the prescribed cost. Due regard must always be had for the principles underlying every form of production, and although a certain amount of work did cover quantity production he could not help feeling that rather too much was said at their meetings about quantities. We should perhaps pay greater heed to the fundamentals of production. Mr. Hutchinson commented on the remarkable progress made by the Birmingham Section. The Birmingham branch was a live branch from the start. It had a membership of about 170 and those who worked at the headquarters of the Institution realised what a tremendous impetus Birmingham had given to the Institution as a whole. They could never be unmindful, he said, of the really solid work that had been done by the Birmingham Section.

Mr. R. H. YOUNGASH, in responding to the toast, said the Birmingham Section was proud of the fact that the Institution had, for the first time, held its annual dinner in the provinces—at Birmingham. They in Birmingham were alive to their responsibilities and while they recognised that the Birmingham Section had shown considerable growth they would not be satisfied until further advancement was made. Personally, he felt that the Institution was destined to become one of the largest bodies of its kind in the country. They welcomed amongst them one or two of the original founders and particularly Mr. Armitage, who was a member of the Birmingham Section Committee. They were much indebted, locally, to the untiring efforts of Mr. Hannay, Mr. G. Groocock and Mr. Wright. There was no doubt as to the need of the Institution, and it was a matter for satisfaction that the six sections—London, Luton, Coventry, Birmingham, Manchester and Glasgow—were recruiting to its ranks the very cream of the men who functioned as production engineers. The utmost care was taken to ensure that only men of proper qualifications and capacity were admitted to membership.

Mr. TOM THORNYCROFT proposed the toast of "The President."

In Sir Herbert Austin they had, he said, one of the finest examples of a production engineer. Two years ago, Sir Herbert told him that he was not quite sure that the Institution of Production Engineers was really wanted, but he now realised, he was glad to say, that it had a definite function and was, in fact, necessary in the domain of modern engineering. They felt honoured that Sir Herbert had become their president, and his hope was that, under his régime, much further progress would be made. A good deal had been said as to what should be the scope of the production engineer and suggestions had been put forward defining that scope in a rather restricted way. He felt, however, that its scope was boundless and that they must maintain that, whatever they might call themselves. The work of their president was an excellent example of co-ordination and co-operation in an industry, and he (Mr. Thornycroft) put in a strong plea for unified action in all departments of engineering. There was no doubt as to British initiative and capacity in the various departments, and he was satisfied that, with the right spirit and with full determination, we would see within a few years our country throughly re-established in all the great markets of the world.

Sir Herbert Austin, in reply, said he hoped all present would go away feeling that they belonged to a very valuable and necessary institution. Although it might not be possible for him to attend many meetings, he could assure them of his interest in the welfare of their organisation. He asked the acceptance of the Institution of a sum of 50 guineas for the provision of a trophy to be awarded say yearly for some special work by the graduates. (Applause). Perhaps the Council, in their judgment, might be able to suggest some suitable form of competition. He certainly felt that the institution had a well defined course, and with the proper spirit of co-operation existing between the various technical and other institutions, he believed thoroughly valuable work would be done for the engineering industry in its many phases.

A successful dinner then terminated.

TENTH ANNUAL GENERAL MEETING.

THE tenth annual general meeting of The Institution was held in the Council Room of the Society of Motor Manufacturers and Traders, 83, Pall Mall, London, on 9th October, 1931, at 7-30 p.m., Mr. E. W. Hancock, Chairman of Council, presided.

Mr. R. Hazleton, General Secretary, read the notice convening the meeting, and after the minutes of the last annual general meeting had been read, confirmed and signed, the results of the

annual elections to the Council were announced.

Mr. W. F. DORMER, London Section President, proposed a cordial vote of thanks to the retiring President of the Institution, Mr. Tom Thornycroft, which was adopted with acclamation.

THE CHAIRMAN, Mr. E. W. Hancock, said that in moving the adoption of the Annual Report he would like to express his thanks at being once again elected as Chairman of Council. It was satisfactory to be able to say that the past year had been one of steady progress. Membership had largely increased, the educational schemes of the Institution had developed, and there was every sign that the Institution itself was now being very widely recognised as the authoritative scientific organisation in the country on production matters. They were looking forward with confidence to the coming year, under the able guidance of Sir Herbert Austin as President. Sir Herbert was known throughout the world as an eminent production engineer.

Mr. H. E. WEATHERLEY, Member of Council, seconded the adoption of the annual report, which was carried unanimously.

Mr. R. H. HUTCHINSON, Past President and Member of Council, said that as chairman of the Finance and Development Committee he had pleasure in proposing the adoption of the Annual Accounts. As an instance of how carefully the finances of the Institution were administered he mentioned that the Budget adopted at the beginning of the year provided for an estimated subscription revenue of £1,191, and that the audited accounts showed that the actual subscription revenue was £1,191 10s. 0d. Expenditure was within £1 10s. 9d. of the Budget estimate. He reminded members that in the early stages of an Institution such as theirs it was incumbent on them all to do what they could to increase the prestige and members of their organisation. Already, he believed, the Institution gave better value for the subscriptions paid than many other bodies. To be successful in carrying out fully the many important schemes which the Institution had in view a larger membership was essential. Membership was growing at a very satisfactory rate, but it would grow at even a faster rate if each of them did what he could to introduce new members of the right quality.

The audited Accounts for 1930-31 were adopted and Messrs. C. H. Appleby and Company were unanimously re-elected auditors for the ensuing year.

Mr. G. H. HALES, Member of Council, proposed a vote of thanks to the Honorary Secretaries of the various Sections for their work during the past year.

The vote of thanks was adopted and the meeting closed.

PRODUCTION TESTING EQUIPMENT.

Paper presented to the Institution, Birmingham Section, by E. W. Highfield, A.M.I.E.E.

Preface.

IT may be that there are those here to-night who are not by any means familiar with the purpose and use of dynamometers. The first portion of this paper is, therefore, intended as a preface to briefly describe various types of dynamometers, and in what manner they are used. The development of machinery of all kinds during the later part of the eighteenth and during the nineteenth century called for reliable means of measuring the work done by, or on, a machine when it was in motion. Progress would probably have been stopped unless, early on in the history of engineering, common units for work and power were devised and accepted. I therefore make no apology to you for quoting complete from a book entitled "The Steam Engine" by John Farey, of slide rule fame, published in 1827. The author of this book, writing on the estimation of the force of steam engines by horse-power in 1784, writes as follows:

"The only unequivocal mode of expressing the mechanical power exerted by an engine or by an animal is the weight which can be raised through a certain space in a given time by that exertion; and unless we define what a horse-power is in those terms, it is a very vague expression, on account of various degrees of strength which different horses possess, and their capacity of enduring fatigue.

"When Messrs. Boulton and Watt, of Soho Works, Birmingham, first began to introduce their rotative steam engines into manufactories, about 1784, they found it necessary to adopt some measure of the power which they were required to exert; this they endeavoured to do in such terms as would be readily understood by the persons who were likely to want such engines. The machinery in the great breweries and distilleries in London was then moved by the strength of horses, and the proprietors of those establishments, who were the first to require Mr. Watt's engines, always enquired what number of horses an intended engine would be equal to. In consequence, Mr. Watt made some experiments on the strong horses employed by the brewers in London, and found that a horse of that kind, walking at the rate of two and a half miles per hour, could draw 150 lbs. avoirdupois, by means of

a rope passing over a pulley, so as to raise up that weight, with vertical motion, at the rate of 220 feet per minute.

"This exertion of mechanical power is equal to 33,000 pounds (or 528 cubic feet of water) raised vertically through a space of one foot in one minute, and he denominated it a horse-power, to serve for a measure of the power exerted by his steam engines; that is, of the resistance actually overcome, in addition to the friction of the engine itself, and the resistance of the air pump . . . Messrs. Boulton and Watt's standard for the horse-power is very much beyond the actual power of any horse, except the very strongest, and they cannot long endure the exertion of raising 33,000 lbs. at the rate of one foot per minute. Mr. Smeaton and other engineers made many observations on the work actually performed by horses when working regularly in mills, and the results seem to show that 22,000 lb. raised at the rate of one foot per minute, may be taken for a real horse-power, or as the exertion that a good horse can overcome with so much ease as to continue work for eight hours per day.

"It may be noted that the first mention of horse-power in print occurs in Vol. 11 of the first edition of 'Mechanics' of Olinthus Gregory, 1805.

"Farey was a friend of James Watt, and a man of much ability, and moreover the inventor of an excellent form of slide rule, which appears to have been much used in the calculation of the dimensions of Watt's engines. Some of the slide rules were devised by Watt himself, and one of his engineers, by name Southern. These instruments were known as the Soho sliding rule, and formed one of the every day tools of the workmen employed by Watt (pp. 531-532 idem), as is evident from the following words: 'and having observed the facility with which the Soho workmen performed their ordinary calculations by it.' I mention this, as I have heard some engineers speak of the slide rule as a new sort of instrument, and therefore one to be avoided. As a matter of fact, the slide rule dates from a much earlier period, probably 1662 (see Nature, Vol. LXXXII)."

It therefore should be of significance to us who are gathered here to-night, that the birth of our universal unit of mechanical power, and the practical application of it, as well as of the use of the slide rule, should have taken place within a few miles of where we are gathered together to-night.

Dynamometers.

As you see from the quotation, even in those days crude devices had to be arranged, mostly consisting of a cord running over an arrangement of pulleys and supporting a weight, for the purpose of measuring and comparing the performace of one machine with another. Such devices we call dynamometers, and they have been developed and elaborated from time to time by many eminent engineers, and it is the purpose of the author to show that the use

of dynamometers to measure engineering performances is as essential to-day as ever it was. Furthermore, that the universal application of electricity has broadened the possibilities of dynamometers in ways not previously contemplated.

Brakes.

To sketch briefly the development of dynamometers. The early engineers almost entirely confined themselves to the simple device of raising a weight at a certain speed, and this was satisfactory as long as speeds were low and time of little consequence. As bearing surfaces and lubrication began to be understood a little better, speeds rose, and the development of dynamometers was at a standstill until the laws relating to friction became better understood. A knowledge of the friction set up between a rope and a pulley to easily control a load had been used from very remote times, but the laws governing the action of such a device were very imperfectly understood. We find that a patent was granted to Lord Kelvin in 1858 for a dynamometer consisting of a rope wrapped round a pulley with a weight suspended from its free end and the fixed end attached to a spring balance. The pulley was mounted on the shaft of the machine, the power of which was to be measured, and therefore the pull or torque exerted by the machine was indicated on the spring balance. The device was developed and improved and is now generally known as the Prony brake. The improvements have mostly been in the way of artificially cooling the drum or pulley, and devices for keeping the rope or strap carrying the weight up to its work. The so-called Prony brake was in universal use without a competitor until 1875, when G. A. Hirn invented the water brake, but owing to the simplicity of the Prony brake, these are still in use, and the author remembers seeing them used in a large Coventry motor factory only ten years ago.

The Prony brake was never satisfactory in any form for use in testing a machine giving a varying torque, because it is essentially a constant torque device, and in practice it is found almost impossible to control the speed during a test unless the torque was held constant.

The hydraulic brake proposals of G. A. Hirn were, therefore, very welcome to engineers, and these proposals were amplified and improved upon in a very clever manner by William Froude in 1877.

The water brake as then proposed by William Froude utilised liquid friction as the load in place of the solid friction of the Prony brake. The frictional resistance of fluids to rotation depends very largely upon the speed, being smallest at a low speed, and rising very rapidly as the speed is increased, therefore, Froude was able to devise a dynamometer in which the resisting torque varied nearly as the square of the speed. This was exactly what was wanted and the Froude hydraulic brake became deservedly popular. In

form it consisted of a casing mounted on trunnion or pedestal bearings, free to turn about its axis and restrained by being linked to a fixed spring balance. Its shaft was coupled to the machine under test in the usual manner, and the shaft carried a type of turbine wheel rotating inside the casing against a similar shaped wheel fixed to the outer casing. The casing was supplied with water, which was set in motion within the casing, and so set up the fluid friction which was actually the load. The reaction to this load of the casing, was measurable on the spring balance. There are several types and makes of water brake available, and in past years their use has been very general.

There are too, various types of air brakes, the first of these being patented in 1904 by Messrs. W. G. Walker & Company. These consist generally of a specially designed fan wheel or paddle which is coupled to the shaft of the machine. The paddles are adjusted in size and angle so that the machine runs at a certain speed. When the speed is known, and also the size and position of the paddles, the horse-power is read from calibrated results supplied with the brake. The results obtained depend so much upon the temperature and barometric pressure of the atmosphere that they cannot always be relied upon, and this form of brake is mainly used for its cheap first cost.

There is also the magnetic dynamometer based upon Arago's experiment in 1884 when he found that a metal disc absorbed energy when rotated between the poles of an electro-magnet. The outstanding practical example of this type of dynamometer is the one patented and made by the late Messrs. Morris and Lister, Ltd., of Coventry. This consisted of a series of electro-magnets mounted to face one another upon either side of a casing, the casing being mounted upon pedestal bearings and free to rotate, but anchored to a spring balance, the shaft being coupled to the machine under test in the usual manner. The rotation of the disc caused eddy currents to be set up in it, these acting as a load and giving rise to a reaction on the casing which was measurable on the spring balance. This brake was quite satisfactory for small sizes, but for big powers the discs had to be water cooled.

There are also a great number of very interesting transmission and torsion dynamometers, all designed with the object of being placed between the prime mover and its load, and of transmitting and measuring the power without absorbing any of it. For instance, a motor might be coupled to a pump by a spring coupling, and the deflection of the spring be taken as a measure of the power it was transmitting. There have been dozens of patents taken out for dynamometers working on some variation of this principle, and some of them are most ingenious and praiseworthy, but so far, nothing of a practical nature has yet emerged as far as the author is aware.

Electrical Dynamometers.

We now come to the electrical dynamometer. We find that an electrical motor or dynamo was used as a dynamometer for the first time in about the year 1881. The dynamo was placed in a cradle so that its casing could rotate, but was restrained by a spring balance. The shaft of the dynamo was coupled to the machine under test and driven at any speed desired ; the electrical connections from the dynamo were to an electrical load of any sort, providing it could be easily varied, and the reaction of the dynamo cradle was read off on the spring balance. This constituted a dynamometer and it obviously had useful properties that none of the types previously mentioned could have. For instance, the dynamo when supplied with suitable electric current would become a motor and give out mechanical power at its shaft, so that the machine connected to it could be driven by it, and its mechanical efficiency measured. Furthermore, we have seen that the mechanical hydraulic and air brake all absorb power which is finally wasted in heat, whereas our electric dynamometer converts our mechanical power to electrical energy at a high rate of efficiency, and the electrical energy so produced could be stored, or transmitted to any distance with little loss, and usefully used for any purpose as may be convenient.

The advantages of the electrical dynamometer are so obvious even to those with the most elementary knowledge of electrical engineering that at first one wonders why it did not at once take the place of all other types. The reason is that the mechanical solid friction and the hydraulic liquid friction dynamometers were developed to a high state of perfection long ago at a time when the manufacture and standardisation of electrical machines was in its infancy. It may be said that only during the last twenty years have suitable materials and design been standardised to such an extent that it is now possible to make large quantities of electrical machines identical in appearance, dimensions, and characteristics, and so far has this development been carried to-day that a state near perfection has resulted.

For reliability in service, consistence of results, compact dimensions, efficiency of energy, transformation, and cheap first cost, the electric motor or dynamo can truly be said to lead the way. It is therefore by reason of all this that we would wish to see the characteristics of the electrical machine fully utilised in the construction of dynamometers, and the extension of the use of dynamometers for comparative measurement.

Electric Dynamometers as an Aid to Production.

For the purpose of this paper it is intended to consider methods by which the mechanical efficiency of any type of rotating machinery may be compared with a known and defined standard of

performance before the machine or parts of the machine are passed out of production as a finished article.

The type of machinery in mind would be internal combustion engines, pumps, fans, machine tools, and similar plant. Any machine made up of a multiplicity of rotating and rubbing surfaces, will depend very largely on workmanship and inspection if the required performance of the machine is to be attained with reasonable economy. So much so is this latter statement appreciated that the engineering trade is wedded to most elaborate and expensive systems of gauging and finishing all the running parts of any modern machine. The author of this paper takes the standpoint, that in spite of the very complete and expensive gauging and inspection systems above referred to, the reasoning behind the idea has not yet been taken to its logical conclusion.

It may be said that systems of gauging and inspection have been taken further in the case of motor car production than in any other trade, and yet how too often does one hear of a car being taken back to the makers for such things as replacement of engine, gear box, and back axle. The cost of dismantling and replacing any component on a machine once it has left the production line is bound to be very high, apart from damage to the prestige of the makers, and inconvenience to the customer. It is difficult to see why more study has not been given to the testing and conditioning of the product as a whole to bring the procedure into line with the recognised practice in regard to components.

It appears that, particularly in the motor car trade, the serious preparation by conditioning and testing under running conditions of the actual finished car, is only fully carried out by the designing department. The highly skilful tuning and costly adjustment which they are able to make on their test cars is assumed to prove that the model will be satisfactory when placed into production, even though in production the conditioning and testing of each finished component, and even of the car as a whole, are of the most sketchy character. Some engineers appear to hold the opinion that if the initial design is right it only remains to produce each component item to close limits and the complete product is found to be satisfactory. This view point is likely to lead to most unsatisfactory results because the close limit production system should be considered almost solely as a means for cheap and rapid production by the elimination of hand labour, rather than as a means of obtaining *uniform* performance of the finished product.

The reason is, of course, that production to close limit jigs and fixtures and gauging and inspection can never be 100 per cent. on an assembly of components making up a machine such as a motor car, and the total sum of such small errors that occur often reaches a magnitude that can give a wide diversity of performance in the finished machine. This leads one to reason that any machine or

sub-assembly on a machine which may consist of a number of rubbing or sliding surfaces, and transmitting power, should be run in or conditioned for a certain length of time dependent upon the finish and fit of its individual components. Therefore, a test of the mechanical efficiency of each sub-assembly of each finished machine may be regarded as the only definite evidence that production is proceeding with the necessary harmony to give satisfactory uniform performance of the product.

Road Testing of Motor Cars.

To again refer to the motor car trade no doubt there are those who will say that as a car is designed, and is bought by the customers to run on the road, the only place to test it out is on the road doing its job of carrying goods or passengers, or with an equivalent load. That this view is general, is proved by the expensive road testing organisation kept by most automobile firms. Yet few of them are consistent in the matter, as most of them test their engines, and some both engines and gear boxes, and still a few test engines, gear boxes and back axles. Furthermore, if the road testing does what it is intended to do, one would hear less of the dissatisfied buyer and of early and costly service on so many new vehicles. Of course, the truth is that it is almost impossible to collect and control a body of suitable men for road testing so that they would give results of 100 per cent. except at a prohibitive cost. Furthermore, the human element with all its vagaries again becomes the measuring stick of the performace of a mass production product.

The author would prefer to see a short track run substituted for road testing as now understood, and that only for checking the functioning of steering, springing, body rattles, and the other small things that usually depend on final fitting and which do not enter into the mechanical efficiency side of the matter. Then engine testing, gear box testing, back axle testing, and final chassis testing on a basis of mechanical efficiency would definitely assure that the product be kept uniform and up to a clearly defined standard.

At this point the author wishes to define what is meant by a standard of mechanical efficiency in case it is thought that the testing of all the above under full load conditions would be too costly to contemplate, and he therefore proposes to take each unit under consideration. First of all it can only be regarded as essential that the design and research staff of an automobile works should have access to a properly equipped laboratory or test house, where all components can be precisely tested under full load conditions, so that they are in a position to cross check the production testing in the event of dispute. These facilities seldom exist completely in this country, though generally to be found in the trade in other countries.

Going on with our consideration of production testing, it is the opinion of the author that at least 10 per cent. of engines, according to type and quality, should do a full load run of short duration as well as the test before and after for mechanical efficiency. The remainder of the engines should be run in for the minimum time required for their mechanical efficiency to reach a certain standard, or in other words, for the power required to drive them at a certain speed to drop to a previously ascertained figure. If this figure is well chosen after proper consideration and test, engines passed to it should give uniform performance in the chassis.

Gear boxes and back axles are a somewhat different case, as the main source of trouble to be eliminated is noise. It is, therefore, necessary that they shall be loaded up to at least 30 per cent. of full load during test, and that over a wide speed range. During the test of these components both noise and efficiency measurement set the standard to be passed. Seven minutes is ample for testing each gear box or back axle, including fitting up and taking down.

Chassis Testing.

Finally, the most important is chassis testing, and here it is surprising to note that little has yet been done. The chassis test is certainly the most satisfying and convincing of all, for results and comparisons can be got from it that can be obtained in no other way, and for controlling the standard of performance and checking the quality of production it has no equal. This is mainly because, in the chassis test the road or track equivalent can be kept constant while precise readings are taken of the power output, and that any given conditions can be duplicated with ease and convenience. Here again, as in the case of production testing, it is not absolutely necessary for 100 per cent. of chassis to be load tested, at any rate as a check on production.

The author suggests that each chassis be run on to an electrical chassis test and motored round at certain speeds, and on each gear with the clutch in until a previously ascertained minimum horsepower has been reached in a reasonable time, and that this should constitute the pass out on production. After this the sales department might take charge of the chassis test, being responsible for standard tuning and running adjustments before handing over to the body department for body fitting, after which a short track run for the purpose previously explained should assure a product safe to hand over to customers without fear of unnecessary service expense.

It will now possibly be understood that what the author has attempted to describe as the checking of production by test for mechanical efficiency consists of nothing more than running a unit under no load conditions at a certain speed and comparing the power demand over a period of time with results obtained

experimentally from a reference unit. The proposal gives security of results because test conditions can be duplicated as and when required. It is therefore the purpose of the author to point out that practical and economical testing or running in plant is available to meet the above mentioned requirements.

Electric dynamometers do not, even yet, appear to be fully appreciated for the purpose under discussion, though the firm with whom the author is connected have made and supplied over 100,000 h.p. of electric dynamometers, most of which are under 70 h.p. capacity. There appears to be an impression that an electric dynamometer must consist of an electrical machine with a specially constructed swinging carcase directly coupled in some manner to a weighing mechanism so that the torque may be measured by direct weight. While it is true that the torque reaction type of dynamometer is the only acceptable type for laboratory and research work, this type is unnecessary and at a severe disadvantage for production testing where rapid indication of results and interchange of units is essential.

For production testing a dynamometer should certainly consist of a fixed frame machine from the point of view of first cost, reliability, ease of repair and ability to match up with other similar forms of plant and unit mounting fixtures. This necessitates an electrical type of indicating meter directly marked in horse-power, in addition to reliable means of indicating the speed.

Motor and Dynamo Efficiency.

It is not necessary to make any claims for the consistency of results or efficiency of either the dynamo electric machine or an electrical indicating meter ; there is ample proof around us in every branch of engineering that these two items of plant are accepted for all sorts of vital service for these very reasons. The efficiency of an electric motor or dynamo varies according to its load, being highest at full load and lowest at no load and therefore, if we read the input or output power requirements of such a machine by means of an indicating meter such as an amperemeter or a wattmeter, we must make a correction according to the point on the load curve at which we are working, or permanently compensate the meter in accordance with the efficiency curve of the dynamometer. Actually, to be effective, one has to compensate for two variable conditions, one being variable armature current, and the other variable field current. To compensate for either of these variables is fairly simple, but to compensate fully for both over the whole scale is rather difficult, and a compromise has to be made, usually at the low part of the scale, if a very wide range of speed is required from the dynamometer. In the fixed frame type of dynamometer, the Highfield Electrical Co. Ltd., guarantee an accuracy of indication of two per cent. over the full scale reading for the old type of in-

strument, but with their new type, a guaranteed accuracy of one per cent. of the full scale reading, when tested against the most accurate form of torque reaction type dynamometer, is easily obtainable. The sponsors of the torque reaction type of dynamometer often state that the readings of the fixed frame electrical indication dynamometer is not reliable even if compensated, because of the variation of efficiency of the machine. There is no engineering basis for such an assertion, and they have yet to advance any proof of it whatsoever.

It will be seen that the robust character of the horse-power meter and the bold open scale make it ideally suited for workshop conditions. Therefore, with the accuracy mentioned above, the type of dynamometer of which this instrument forms a part is most suited for production testing as previously discussed.

Control gear for use in connection with electric dynamometers should be of the simplest and most robust character, and so designed that the operator requires to make no mental effort in operating the controls. Push buttons, controlling contactor type switch gear, best fulfils this requirement, and by their use, together with graded variable resistances operated by conveniently placed hand wheels, it is possible for the operator of a modern electric dynamometer to concentrate all his attention on the actual unit under test. The controls should be grouped at the finger tips, and all indicating meters at normal eye level. The required movements to effect change of speed or load condition should be instinctive and capable of being made without taking more than a moment's attention from the unit. With proper experience in the design, and by the use of good quality apparatus, these requirements can be satisfactorily met, and the plant therefore becomes quite safe to place in the hands of a semi-skilled operator if only routine production testing is to be undertaken. Therefore, it may be taken that there is usually no difficulty in designing electric dynamometers to meet almost any conditions as far as speed and power range or shock loading conditions are concerned. In most cases regenerative loading is possible, so that the only power taken from the line is that required to make up the losses.

Examples of Production Dynamometers : Motor Cars.

A few actual examples of the use of production dynamometers for the purpose of checking production will now be given. We might take as a first case the fitting of a six-throw petrol engine crankshaft to its mean bearings, as carried out by a certain well known engine manufacturer. The main journals on the shaft were ground to final finish and size within certain very close limits, and fitted to finished *turned* white metal main bearings. The bearing caps were pulled down with the maximum pressure obtainable without actually deforming the white metal, the crankcase and

shaft immersed in a bath of oil, the crank coupled to an electric motor of 50 H.P., and the crank driven over a speed range finishing up with a maximum of 750 H.P. The power chart revealed that the power required to drive the crank under the above conditions fell till it attained a certain steady figure at a given speed after a certain lapse of time. This was found to be precisely when the journals and bearing had attached the best possible finish and fit and no further effort was made to improve the finish of the crankshaft fit, as it was found that no further improvement was possible. It will be seen that in this instance the power measurement of the electric motor and the method of using might be considered as a dynamometer and thus used to check and secure a definite result. It may be thought that this method of fitting a crank might be termed brutal, and it is only mentioned here because the method would be impractical on a production basis were it not for the electrical drive and control.

We can take another instance where a certain six-cylinder engine, after final assembly, was connected to a variable speed electric dynamometer where the speed was arranged to vary and the torque was fixed. In this instance, if the engine, as received from the fitting bench, was stiff, the rotational speed would be low, whereas if the engine was free the speed would be high. The speed at which the dynamometer motored the engine was therefore taken as a reliable guide as to the consistency of the fitting of the engine, and furthermore, by reading the horse-power meter showing the input of power to the dynamometer it was possible to check the assembly department and maintain a high standard of production. In the particular engine in question it was found that on an average it took initially 6.5 P.H. to rotate this engine at approximately 250 R.P.M. with an input of power of 3.5 H.P. It was realised in this particular case that the methods of fitting, the finish, or the mechanical design of the engine might be altered to improve the running in time, as the figures were not comparable with other engines of the same size. Certain alterations were therefore made, and finally with slight variation of the method of fitting the main crankshaft bearing and the piston clearances, the initial starting power was brought down to 5 H.P. and the running-in time to two and a half hours, and what was more important, the engine maintained its tune on the road over a longer period than ever before, besides giving more power.

In another case it might be mentioned where a big production of small four-cylinder engines was taking place, it was decided to give a dynamometer power test to approximately 10 per cent. only of the engines produced, but to run-in all engines on an electric dynamometer for a given time. It was found that faulty engines, that is to say, engines faulty from a mechanical point of view, showed up materially upon the running-in stand due to their excessive power

requirements and low speed, and after some experience such engines were immediately rejected and returned to the fitting bench for rectification. It was then found that all engines which had passed the running-in bench and attained a certain minimum horse-power at a maximum running-in speed within a given time, were always satisfactory engines when transferred to the dynamometer working on a power test or when running in a chassis on the road.

A certain firm announced a new model car which was reputed to have an extremely good engine performance. The demonstration cars certainly justified this claim, but the cars received from production were disappointing, as the engines did not have the power expected. On an investigation, production engines were motored round on electric dynamometers, and the running parts and components dismantled one by one to ascertain the effect on the mechanical efficiency. Various improvements were made to the drive to components, but the main improvement effected was in the alteration of the mounting and drive to the water pump, which originally accounted for a loss of 3.5 P.H. at a certain speed. The trouble was quickly cured without further complaints from customers.

An interesting case was that of a car that had a bad reputation for burning out main engine bearings. All sorts of alterations had been made without affecting the actual design of the crankshaft. The alterations were mainly directed to improving the flow of oil and its cooling. When electric dynamometers were installed, the makers were induced to take motoring tests for mechanical efficiency, and were surprised at the power required to drive the engine. The engine was dismantled piece by piece, and tests taken at each stage until only the crankshaft was left. The tests showed that over a certain speed this was taking much more power to drive it than it should have done, and it was finally decided to re-design the crankshaft and crankcase, and after this the trouble was eliminated.

In the case of gear boxes, a certain firm that had fitted their gear boxes directly to the chassis without previously testing, found that the total rejection and service replacements were as high as 30 per cent. They then installed electrical gear box testing machines, and after a time were able to reduce the figure to three per cent. only.

There are many other instances in the motor trade within the knowledge of the author, where information essential to satisfactory production has only been obtained by the use of electrical dynamometers.

Grinding Machines, Hydraulic Pumps, Fans.

In yet another field of engineering there was the case of a special grinding machine which, in the opinion of the buyer, took an excessive amount of power. When driven by an electric dynamometer

the power input running light was thought to be much higher than necessary, but the makers blamed the special system of bearings for this, as great rigidity was essential. The dynamometer tests resulted in the design being reconsidered, and alterations were made that resulted in a power saving of 40 per cent.

A maker of hydraulic pumps was induced to use an electric dynamometer to check final assembly, and obtained information from it that caused him to re-design his line of pumps almost entirely, obtaining better efficiencies and lower production costs.

In the case of fans, the precise power measurements obtained by tests with an electric dynamometer at a certain engineering college has, to a large measure, resulted in the old theory for fan design being abandoned and an entirely new theory substituted, based on aero dynamics.

Machine Tools.

In the course of contract work, the author is frequently called upon to supply electric motors to manufacturers installing new machine tools. The buyer usually asks for the size of motor specified by the maker of the machine tool, and in many cases the motor, when placed into service, is found to be too big, or more often too small. This leads one to suppose that machine tool makers could usefully use electric dynamometers, for either their existing method of arriving at the horse-power required is unreliable, or their machine tools are not uniform in mechanical efficiency.

Conclusion.

It is pleasing to note that from enquiries received, the advantages of using a tested electric motor and an indicating meter calibrated in terms of horse-power as an electric dynamometer are becoming more and more appreciated in widely different sections of the engineering trade.

It is common knowledge that the control of the vast amount of electric power used throughout the industries of the world has only been made possible by the absolute reliance that can be placed upon electrical indicating and recording instruments.

The ease with which an electric current can be produced and transmitted and the confidence with which it is used as almost the sole motive power in industry, is because the electrical engineer can rely on his measuring instruments, and safely base his calculation for definite performance thereon. It is therefore hoped that engineers engaged in other branches of the art will increasingly avail themselves of these advantages, especially in the manner suggested in this paper. A little reflection should convince them that they can do so with confidence, and as the idea becomes more generally accepted, the plant and apparatus required will become cheaper and more adapted to meet their special requirements.

Discussion.

MR. R. H. YOUNGASH, Section President, who presided : It seems to me very remarkable to see the advances that have been made in this particular field of electrical testing. The point that struck me most forcibly is that the principal method of testing is by the input rather than the output of power. Many of you will have had some experience with the early method of electrical testing such as used to be the vogue, where we had a barrel of water, some salt, and a couple of lengths of piping for anodes ; this was a very unsatisfactory way of testing, and the idea of putting this power to some useful purpose will obviously please production engineers by the conservation of energy. Personally, I do not think the whole field has been by any means explored yet. I am visualising the application of this particular method of testing to ascertaining accurately the power absorbed by cutting tools—that would be a very valuable and useful means of comparing the relative performance of different kinds of steel, different cutting angles, etc. That is a point to which we, as production engineers have not, up to the moment, given nearly sufficient attention. We instal a machine because it produces a piece in a given time which is better than we have done before, and too frequently ignore the fact that we have spent most of the saving in horse-power in doing so.

I was also particularly interested in Mr. Highfield's remarks on chassis testing. I do not think I am entirely convinced that he can eliminate road testing, although he may have gone a long way in that direction, but I do know that up to the moment, at any rate, no method of avoiding road testing has been found. I have in mind two particular instances where a lot of time, trouble and money were spent in trying to devise something for that particular purpose. The first is the well-known Lanchester method of perhaps thirty or more years ago, where Dr. Lanchester put a drum into the floor of a cellar and ran his car over it. He made this drum eccentric and rather odd in shape in order to give the necessary oscillation, and then attempted to measure the power that he got from his wheels whilst the car was fixed and rotating the drum, and thus produced in some measure the road test conditions. That was the earliest method, but I think it failed because at that time we had not the advantage of the wonderful measuring instruments and recorders, and so on, that we have to-day, and a greater part of the advancement lies perhaps more in this direction than the mere application of electricity through improved dynamos and generators. I also remember another scheme which was tried by by the firm with which our president is connected, where we put the chassis on two hydraulic jacks and drove from the two rear wheels (solid tyred in those days) by means of a broad belt on to a couple of propellers immersed in a tack. The propeller, of course,

is one of the more accurate methods of measuring power performance, certainly more accurate than the fans that Mr. Highfield spoke of.

There is one point I should like to have heard Mr. Highfield say something about, and that is, how he measures the horse-power in turbines of large powers, such as are used for the propulsion of ships ?

Mr. E. W. Field : If I were a member of the motor car trade, perhaps I should feel inclined to strike back at Mr. Highfield, but as far as the machine tool trade is concerned, I am afraid I should have to sit down and hang my head, because we certainly are behind hand in measuring mechanical efficiency. Engine builders, from that point of view, have progressed. Their relative output per unit is higher than we can get. The time will come when you gentlemen will approach the machine tool maker and say, "If you will test this with a dynamometer, we will give you another £10, and shall demand in return a specific efficiency." Possibly along these lines something may be done. It is very difficult to see how one can, on a falling market, spend more money in testing a unit which is moderately efficient. As one goes round the huge machines that the automobile people are putting in, one wonders if the extra half a minute is always worth the extra unit needed to drive that machine !

Mr. I. H. Wright : Often the question of testing is really very complicated. For example, in speaking about the testing of a grinding machine, Mr. Highfield said that the conditions necessary to produce a certain class of work had almost driven the builders of that certain machine into mechanical inefficiency, and that when one has catered for the peculiar expert opinions of buyers of machine tools, it would hardly be fair to make the machine tool maker responsible for a high mechanical efficiency. There is also a kind of axiom in production shops which applies not only to machine tools but to motor cars, that power is the cheapest thing we have; that is, if you can do a thing by power instead of letting a man do it by hand, do it, and of course that axiom works often to the disadvantage of mechanical efficiency with, probably, waste of power. Mr. Youngash said that machine tool makers ought to do more testing. It would be interesting to visualise a means not only of saving power, but of indicating what one is doing. I have often wondered why, in motor driven machine tools, people do not insist on an ampmeter or current indicator on the machine. You have automatic machines, say a multiple drilling machine, with a lot of drills in it, or with an expensive set-up of tools, any tool or group of tools of which may deteriorate if they are allowed to cut at too great a speed. There are tool fractures, and a hold-up of the machine, and other disadvantages, whereas if an ampmeter in a visible position were installed on this machine, the increase in power

required would give warning and would very often allow the machine to be re-set at night, or something of that kind, and save inconvenience and very costly hold-ups. Every motor driven machine, except the very simplest machines, needs a current indicator.

When we do begin to test machine tools, we shall want to test not only the horse-power put in and going out, but to get data about the cutting operation itself for the purpose of designing machines which are desired to be highly efficient. Take the case of a milling machine. It is essential in such a test that the work should be as firmly supported as possible, so that it cannot be supported on anything that is going to spring and jump about as it operates the testing gear. Many attempts in that direction have been made, but they have all involved a thin metal container with fluid and a pressure gauge on it, but even that involves a yielding movement to operate the indicator.

It has often occured to me that some kind of indicator might be devised electrically, by which the pressure would be indicated so as to produce something of that kind with a very infinitesimal yielding and without the elastic metal sack filled with blycerine, and the indication would probably be more sensitive. I should like to have Mr. Highfield's opinion, in just a rough way, of the possibility of something of that kind. The load indicator could be put between table and work so that the bearing force is indicated without the piece itself having to move seriously.

Mr. J. H. Garnett: As an outsider who has probably seen more of Mr. Highfield's work than most people, I cannot but be impressed at the results achieved by the electric dynamometer method of testing. I have seen all the plants that he has shown us on the screen, and know they are all doing very good work. The efficiency of the electric dynamometer is demonstrated in several ways. In the first place it reduces the testing of engines, units and so forth, to a simple manufacturing operation which can be effectively conducted by a comparatively unskilled man. With other systems of testing the work is conducted more or less by laboratory methods, which to my mind is entirely wrong. It is generally accepted that production is an exact science in which manufacture proceeds on clearly defined lines. Operations are sub-divided into simple processes which are readily performed by any operator with a knowledge of the mechanical procedure at the machine concerned. To depart from this system at the final stage of manufacture, that is, when testing, demonstrates an inability to carry production through to its logical conclusion. Considered from this angle, the electric dynamometer represents the final link in the production line, inasmuch as it puts testing on the same footing as other processes, and gives precise results without regard to the human element.

A point which Mr. Highfield has not stressed is power economy.

With the production type dynamometer, power developed by engines under test can be fed back into the mains and usefully employed in the factory. Some years ago, when going round the Morris plant, I was informed that the power generated by engines under test and utilised in the factory amounted to something like 12 per cent. of the total power bill. When the size of the Morris engine plant is taken into consideration, a saving of this amount will be realised as important. The size and power to which modern aero engines have attained provides food for thought as to the possibilities of power saving by the use of electric dynamometers. At one large works I have seen as many as eighteen aero engines under test, each developing from 1,000 up to 2,000 H P. The cost of developing this power is enormous, and when one considers that equally costly methods are employed to absorb and dissipate the power, the need for more effective methods is apparent.

As compared to road testing, the electric dynamometer gives definite results which are obtained under supervision, and can be relied upon. Road testing is generally unsupervised and wasteful of time, and if my own experience of the roads round about our motor-manufacturing towns is any criterion, I would say it produces anything but the results that are desired. Certainly new cars get a good parking test, but I doubt if they get much beyond this. I was recently in the company of a man who had bought a well-known make of car which had evidently given him a lot of trouble, and during the six months it had been in his possession, it had been back to the makers' works repeatedly for such things as the fitting of new engines, gear boxes, back axles, and so on. Most of these complaints could have been eliminated by a proper system of testing. The owner of the car was by no means dispirited at his experience, and expressed himself as willing to buy another car of similar make when the time arrived. To my mind this demonstrates a faith which the manufacturer should prize very highly and endeavour to retain. He can do this by attention to testing methods, and in doing so reduce his production and subsequent service costs with resultant greater satisfaction to all parties concerned.

MR. H. C. ARMITAGE: I should be interested to hear from Mr. Highfield how he measures sound. That was mentioned only at the last minute, but it struck me as being one of the most interesting developments in the whole of his lecture. After all, sound has still no standard, and I should be very interested to know if there is any means of making some standard or indicator that can gauge at least the elements of sound emission. Another question is, I take it that all these motors or generators are D.C., and if so, are they combination motors? The object of that, I suppose, would be that the load or efficiency of the motor would be fairly constant through the range of tests, and in any case it has got to be constant,

that is to say, the indications of the dynamometer have got to be constant throughout the varying speeds ?

MR. HIGHFIELD : That is already done in the instrument ; the instruments are compensated for it.

MR. S. G. BROWN : I feel rather ashamed of entering into such a discussion when I realise that only six years ago I was testing high speed steam engines with a length of timber and all the weight we could get in the plant. It is quite easy to see how desirable a proposition a dynamometer would be under those conditions. Mr. Highfield mentioned, in the case of applying this to a crank shaft, that one had to screw the caps down without distorting the white metal bearing. I would like to know what means he has of determining when he is distorting the white metal bearing, and whether the readings would indicate immediately whether the white metal bearing was distorted ?

MR. W. G. GROOCOCK : This is the first night that our new Section President (Mr. Youngash) has occupied the chair, and it is a distinct compliment to him that we have had such an excellent lecture, and so good an attendance. It is also very appropriate that the first lecture this session is on an electrical subject. Next week we will be celebrating the centenary of the discovery made by one of the world's most famous men, Faraday. That is particularly significant because had it not been for Faraday's discoveries, these dynamometers that Mr. Highfield has been discussing with us to-night would not have been possible. Such dynamometers are based on the fundamental laws discovered and enunciated by Faraday.

As a production man I remember the time when the only standard for dimensional measurements that I and others in the trade had was a foot rule. To-day we have micrometers and highly sensitive measuring machines. The difference between the old dynamometer and the present electrical one is almost exactly parallel to the above case. With the measuring machine we know exactly what we are doing so far as dimensions are concerned, that is, we have a real standard with very little deviation from that standard. In the discussion the machine tool people have been mentioned, and I certainly think that they (the machine tool trade) could with advantage use the electrical type of dynamometer. I believe this would be an extremely useful tool because it would tell them much about what the machine is doing, not only as a whole, but in its detailed parts. I know machine tool makers, like the rest of us, have at the present time no money available for such extra equipment. In this respect we are all very much in the same boat, but what we have to ask ourselves is, not whether we can afford new equipment, but whether we can afford to do without it. Even if it is true at this particular stage the machine tool business cannot afford this type of measuring machine—and fundamentally

it is a measuring machine—there are a number of secondary considerations which make such a tool valuable, and one of these is the saving of time in arriving at the necessary data. There is only one question I would like to ask about the lecture, and that is, how Mr. Highfield arrives at the efficiency of his electrical machine? We know that electric motors are efficient up to a certain point, under a certain load, and as we are dealing with various load conditions, I should like Mr. Highfield to tell us just how such varying conditions are taken care of when the reading on the dynamometer is taken either from the ampere meter, or read off directly in horse-power. I know how to get it from a curve, but I would like to know how it is taken care of under the varying conditions named by Mr. Highfield.

MR. HIGHFIELD replying to the various speakers: In regard to our chairman's remarks, I wish the machine tool trade could appreciate the importance of what he has had to say in regard to power absorbed by cutting tools. In the machine tool trade there are a number of possible applications for dynamometers for investigating the performance of machine tools and cutting tools. In regard to road testing, I am afraid the chairman was rather hard on me. I do not mean to say that road testing should be entirely done away with. I would confine it to a track near to the works where you could keep your eye on the testers, testing only for steering and body rattles. Then our chairman raised a very interesting question regarding the testing of turbines. Obviously speeds are far too high for testing by means of water dynamometers, and therefore at the present time there is only the electric dynamometer. At present we are coupling two huge dynamos for testing seagoing turbines. Often these are not given a run, but put into the ship, and the performance of the ship is taken as a measure of the turbine efficiency. I regard that as wrong, and have been for some time experimenting with a type of dynamometer which consists of two very small alternators fixed at either end of a propeller shaft connected together electrically in position to a volt meter so the phases balance out, and if there is any torque on the shaft, the shaft begins to twist and there is another reading on the voltmeter. As soon as the turbine delivers power and drives the ship, there is always a whip, or torque on the shaft. When this long shaft begins to twist, it puts one alternator slightly out of phase with the other, and the voltage is shown on the voltmeter proportionately to the twist. A reading is then taken from a second voltmeter graduated for horse-power.

Mr. Wright mentioned power as being the cheapest thing used in production, and undoubtedly it is, but at the same time, I still say that a dynamometer that measures all the power used to drive a certain machine tool would be most useful. Mr. Wright made some illuminating remarks in regard to the use of ammeters on

machine tools. My advice is to have a good meter put on to your switchgear. It will definitely tell you when something is happening you ought to know about. You will know from the readings, even if it is an ordinary, plain gravity type iron meter, just what the machine tool is doing. If the reading is higher it will definitely tell you that something is the matter and something should be investigated. We feel that so strongly that we have recently started manufacturing a stronger and more robust type of ammeter than is usually available, specially for workshop use, and I hope these will be on the market in the course of a few months.

The question in regard to a special indicator for the table of a milling machine. At the moment, I would suggest that a device working on the electric condenser principle, or by the rectifying pressure between two crystals, would definitely enable a measurement to be made. It is well known that a number of condenser plates in a box supported by insulators is very sensitive, and that quite a light pressure on the crystal set endways to its grain, as is used in wireless, can be used to measure force.

Mr. Garnett mentioned the question of power saving. If an installation is properly laid out, dynamometers save power because, instead of being absorbed, the current generated by dynamometers can be usefully employed. In regard to airplane testing, that is a subject that we have got very near to our hearts, and I am not telling tales out of school when I say the Air Ministry have not up to date looked with favour on any of the existing forms of airplane engine testing. We are just now carrying out tests on an alternating current dynamometer which is, up to date, highly successful. When you think that a new type airplane engine has to be run one hundred hours at full load, taking petrol up to one hundred gallons an hour according to size, and at the same time you are expending 300 to 400 H.P. in trying to cool the engine, it is obvious that something is wrong. We are trying to utilise all the power from the engine.

Mr. Armitage was interested in sound measurement. The actual theory of sound measurement is exceedingly easy. Until recently there has not been a unit as a measure of sound, but wireless engineers getting together just recently have devised a unit. If you have got a measuring apparatus such as a milliammeter, and one sound gives you, say, then milliamps, you can compare this with another sound, and if that gives twenty, you know it is twice as loud. It is done in this way. You can imagine a gramophone pick-up being connected with an amplifier so that results are amplified up and then rectified and put on to a sensitive instrument such as a milliammeter. They have to be rectified because the meter works on direct current, the pick-up on alternating current. If your milliammeter is designed with linear characteristics, it is obvious that the current is a measure of the sound. All measures are merely comparative

with a standard of reference. They are not absolute in any way. We can safely use the reading of a milliammeter as a measure of our sound, and it is very effective, but the practical difficulty is in designing a microphone which will not be affected by outside factors. We have had to devote a lot of time to devising a suitable pick-up that will not be affected by outside noises. We do it with a device that is constructed on the same principle as a gramophone pick-up, and we bring a steel stylus into contact with a gear box, back axle or whatever it may be, and that picks up vibrations of the box.

Mr. Armitage also enquired whether these dynamometers were direct current or alternating current. As a matter of fact, the direct current makes a better dynamometer than the alternating current, and is more easily constructed. You have better speed range, and you can measure at varying speeds, of course, quite easily, therefore it has many natural advantages but it has one disadvantage. It has got to have a commutator and brushes, which must be kept clean, but on the other hand, people are used to using direct current motors in industry and have no more trouble with a commutator on a direct current dynamometer than with a direct current motor because it is exactly the same. If you go over 250 H.P. and have a speed of 250 R.P.M. you definitely cannot use direct current. Frankly, for airplane purposes, we stuck at that until we induced people to have confidence in using alternating current.

Mr. Groocock spoke about measurements. Measurements, after all, are comparative, and with any electrical instrument you are able to get closer comparisons than on almost anything else. I would mention the case of pyrometers used in heating furnaces. There you have a very small thermo-couple delivering only a fraction of a volt to a measuring device of the most sensitive type of milliammeter or microammeter that it has been possible to construct, yet these things can be kept in good order for years on end, and will give you true, reliable indication of heat treatment. Heat treatment would be impossible without them. Mr. Groocock raised a most interesting question as to how we arrive at the efficiency of these dynamometers. The first thing we do is to get our efficiency curve by calculation. We then couple up the dynamometer and test it against torque reaction. We check the calculated curve by the curve actually obtained from torque reaction measurements, and we find these always agree within certain definite limits. We only check those, not because we have no confidence in electric calculating efficiency, but because we know we are bound to be asked at any time to give an efficiency curve, and therefore we give an efficiency curve taken by torque reaction. It takes a lot of time and perhaps it is rather expensive, but we have got it down to quite a fine art.

A cordial vote of thanks to Mr. Highfield for his lecture was adopted.

DISTRIBUTION, MEN, AND MANAGEMENT.

Paper presented to the Institution, Coventry, London, and Luton Sections, by James G. Young, M.I.P.E.

Efficiency in Distributing.

THE necessity of knowledge of the products by sales department and distributors is the first essential for volume sales at a profit. Keep salesmen informed of impending changes, but do no put these forward in such a manner, that sales of the present product are impeded. Encourage distributors to criticise weaknesses, and suggest improvements ; but do not endeavour to incorporate every change suggested immediately, but notify distributor when changes can be made, or why it is not economical to introduce such changes. Bring out the features of your products in publicity, if possible create a regular theme so customers and prospects automatically look for your advertisements. Remember always, service is the personal touch between you and your customers, and is the best means of obtaining repeat business. Instruct salesmen their customers are always right, and also see salesmen support the factory no matter what is wrong, for salesmen can easily lose much goodwill by assuming they are let down by incorrect shipments from the factory. This loss of goodwill is much greater if the salesmen are not qualified to understand discrepancies that may and do arise. Never overestimate the value of your products. Let the customers get more out of products than you estimated. Appreciate competition and keep ahead of it, be a leader not a grouch. Healthy competition is the best stimulant in business. Having set a policy of distribution and finding it profitable, leave well alone and be content with increased turnovers.

Don't encourage overstocking by distributors. Goods in their hands are not sold. The most successful companies are those that keep stocks down, so there is always a demand even in slumps in business. Another advantage from this is, that in any changes of design that may have a larger public appeal, manufacturers are not left with large stocks of obsolete goods, either in their factory or on distributors' premises. Remember, although mass production is easily possible, there is no such thing as mass selling, and the consuming public is always fickle and subject to rapid change in purchasing outlook. Hold regular sales development meetings, and keep in touch by doing so with the purchasing public, see that all salesmen unable to attend any such meetings are given the high points from these meetings. Whenever possible give the sales

Coventry, October 7th ; London, October 9th ; Luton, November 11th.

executives working models or samples of the saleable products, and keep these up to date. Never permit salesmen to fix prices ; see these are properly controlled, and carry the confidence of the management, amongst whom should be the head of sales. Once a policy is understood keep it in force. Be sure distributing costs are understood by the distributors, and beware of service charges eating up all profits. Keep salesmen happy by maintaining a policy that encourages them to sell, and do not be afraid to give credit for sales to individuals whose territory the sale is made in, even if he did not actually pick up the order. It encourages greater efforts. Keep accurate records so the salesmen know how they are getting along regularly. Provide some assistance so they may receive some regular statements, and balance up at least every month. Ninety per cent. of salesmen are notoriously bad book-keepers in keeping records, and usually the best salesmen are the worst in this respect.

Separate records should be kept of the cost of salesmen's calls, direct mail efforts, advertising efforts, and where district sales offices are maintained give consideration to these as increased overheads, and analyse these figures so that judicious handling of one with the other will reduce costs and increase volume. It is possible after investigating these figures to use salesmen to concentrate on worth-while accounts, which really justify the cost per call, and the same can be said for direct mail and advertising sales returns, with almost immediate knowledge of the advantages of either method and the opportunity to balance costs and sales turnover. There is urgent need for sales research, and business must rely on its relief from its present embarrassment on scientific selling and distribution. Too much effort has been spent on increasing efficiency in production at the expense of the more urgent need to analyse distribution and sales methods, quite a good reason for this is that leadership in industry is recruited either from production departments or financial sections, and some remoulding is essential.

Dangers of Standardisation.

As a member of this Institution, it is only right that I should warn our members to be cautious in crabbing designers, by looking to constant standardisation and encouraging stultification. When designers are forced to think in terms of averages as expressed in the products manufactured, there is little chance to get anything better than averages. When standardisation in a factory begins to function to the extent that any new component or material will not be permitted because " it is not our standard," then design development progress is likely to reach a low ebb.

Standardisation, generally speaking, is a worthy aim. Many companies could do more than they are doing in the interests of economy by reducing the number of varieties of products and parts.

But what is medicine in reasonable quantities may be poison in large doses. Instances can be pointed out where standardisation has had deadening effects. Real progress in refining and improving products cannot be obtained unless the engineer is free to use the best of new things being offered, and unless he keeps abreast of developments in fields related to his own.

Production engineers can profit by a course in history, in the history of engineering inventions. It is useless to think to-day we have a wonderful invention and expect the public to share that view.

The telegraph is a very good example to follow in history.

In 1753, Charles Morrison, a Scot incidentally, proposed to send messages by electric impulses, and worked out a code of strokes and pauses on a bell. This was followed by Sir Francis Ronald building an instrument using a pith ball actuated by a charge of static electricity sent along a wire.

But it was eighty years afterwards that Morse perfected the commercial electro-magnet telegraph.

Why ? Because one essential element was missing all the time ; a method of applying a continuous current of electricity.

The airplane was invented in 1831, but lacked an engine. Langley actually flew a model plane in 1893, but it lacked light motive power and means of taking off.

Let all who think their product of to-day is the " best " look to what is lacking.

There is probably at least one thing needed to give additional public appeal that means increased sales. It is the function of production development engineers to find those points by study of consumers' needs and sales will naturally follow.

Anticipate Change.

Industry can, and does, make the error of outstaying the market. One well-known automobile manufacturer made this error with a low-priced car, which sold mostly on price ; in his case, however, the cost of a change would have foundered any ordinary company, but what was lost during the period while a new model was being developed would have broken all but a very few of U.S.A.'s largest manufacturers. Because of the enormous size of automobile plants, the complexity of manufacturing organisations, and risk involved in any development that swings far from accepted standards or styles. American automobiles have not shown many radical changes in recent years. The same restriction handicaps any industry where large scale production and tremendous equipment inventory are concerned. There is all the more reason, therefore, for engineers in industry to be forearmed against the dread of change, which is sure to rule production executives. The only way to overcome this

dread, is to keep constantly in the foreground the spectre of an even greater expenditure if the changes are not made.

New Products Essential.

New products are essential for many industries to continue their volume of sales, and a cue should be taken from rubber manufacturers. One large concern gave their employees the opportunity to suggest articles that could be made from rubber, which are at present made of other materials. Try this, it costs very little, and certainly gives employees an opportunity to feel they are part of the organisation. Aluminium is another example of creating demands, and is gaining faster in extent of use than any other metal. Two years ago, aluminium was for small objects only, a few hundred pounds being the limit of a pig. Now, an ingot weighing 3,000 pounds is obtainable, and structural shapes ninety feet long and ten inches deep are produced. One large building in New York City has over 400 tons of aluminium in the spandrels that tie the windows together, making this 85 storey building look taller than it is, and the mooring mast for dirigibles on the roof is sheathed in aluminium. Aluminium ink has found its place on high speed rotary presses, giving white metallic effect in advertisements, and metallic inks are quite familiar. Another use is aluminized putty, this can be spread by gun or putty knife, and should find general use in factory maintenance work ; it doesn't shrink, crack, dry out, or fall off when submitted to vibration, due to flakes of aluminium preventing oxidization and drying up putty oils. Aluminium covered cable is a new development for electrical transmissions, saving considerable weight. Aluminium truck bodies are possible as there is obviously a limit to the load six wheels can carry or safely bear, often fixed by law, and the less the truck body weighs, granted proper structural strength the heavier the load that can be hauled. Overhead cranes with aluminium fabricated sides are quite successful.

Another fine opportunity for increased business is to get the chain stores into delivery service to customers. Individual stores giving delivery service do occasionally force chain store delivery, but the whole problem needs analysing, for there is room for plenty of motor transport and delivery vans ; also transport now idle could be used, for statistics show nearly 90 per cent. of all trucks in use are two-ton capacity or less.

Aeroplanes offer the greatest opportunity for business prosperity and shipping companies must look to this industry as a means of aiding prosperity in their particular activities. Ships for the future must be designed to pick up aeroplanes many hundreds of miles out from land so the passengers may continue the journey, and also be able to release aeroplanes so that passengers may reach their destination with a great saving of time. A few ships laid down in the last decade have been constructed so as to accommodate aircraft ;

also attention has been given to speed, but most of the efforts made is for capturing Atlantic sea trade, and if more general attention is given by shipping combines to encourage and co-operate with aircraft, shipping will not suffer losses comparable to percentage of losses the railroads were saddled with, owing to the inability of the railroad directors to encourage road transport, the general apathy of railroad leaders was encouragement to transport companies who have captured a considerable percentage of commercial transport business, both passenger and freight.

With the demand for commercial aviation, many new industries will spring up, for once the public becomes airminded, luxuries at first become positive demands and the aircraft limousine is going to be fitted out far beyond the standards set by automobiles as the conditions obviously permit the very best that the desire demands in comfort and convenience.

Conclusion.

Business is a co-operative effort on the part of groups of people collectively and advantageously to render some service for society —to supply it with shelter, fuel, automobiles, trucks, railroads, churches, theatres, newspapers, periodicals, books, food, clothing, necessities, comforts, and luxuries. To view business from any other standpoint is to misinterpret its purpose, business and the interests of society are best served when business operations are conducted harmoniously and efficiently. The sequence in which we are usually given to thinking of business, is: To make—to sell—to profit—to serve, the idea being to make something to sell at a profit, and in so doing to render a service. This would be all right if it worked, but experience has proven, that only as the thing made and sold renders a service will the thing desired, namely profit, be in evidence. Since this is a fact, why does not every man in business see the wisdom of giving first consideration to that which is of first importance? The logical sequence for consideration of any proposed business venture is: To serve, to make, to sell, to profit. Can this thing or service be so designed and so made and sold as to be of superior service to a sufficient portion of the consuming public? If it can, there is no need to give consideration to the question of profit, for it is no longer a question, but will be in evidence.

Discussion, Coventry Section.

Mr. SCAIFE : Mr. Young has covered a very wide range in his lecture, and I think the only objection I have is that his remarks might have been well addressed to general managers rather than to production engineers. Many of his remarks have been on points which we cannot influence. On the general remarks about service I entirely agree with Mr. Young. The whole object of our existence is to serve, if we understand life properly. As a production engineer that has been my object in life all through. I think there is something deeper than merely making money and earning a wage. Mr. Young mentioned sales engineering as some branch of this Institution. We have talked about that at Council Meetings, and my own view has been that a machine tool salesman ought to be a production engineer. I should like to see a sales engineer ranking just the same as one of us.

Mr. YOUNG : As regards the sales engineering side of the Institution, I was not speaking in terms of machine tools generally, but I was taking the whole question of sales. Sales engineers must understand the selling point as much as the engineering side. It is no use for the production engineer to leave his job and finish with it ; he must keep up with the times and understand what is going on. If we did that our companies would be better off.

Mr. GRIFFITHS : I would like to thank Mr. Young for bringing in a new aspect to production engineers' lectures. He put forward the suggestion that one of the best ways to get going is to develop trade by new products. One of the snags is that it is almost impossible for English manufacturers to get the capital to help them to develop new industries. We must appreciate the fact that before we can have sales we must consider the market.

Mr. DRANE : Mr. Scaife has expressed one of my own views in regard to service. I should be very interested if you could tell me the result of asking the employees what they would like to manufacture. I can hardly see it applied to conditions under which many are working to-day.

Mr. YOUNG : It is very much easier for a firm employing a few people to ask the employees' opinion, than it is for a firm employing 3,000, but a percentage of employees will make sound suggestions, and the company that did take heed of the suggestions called for were able to find products to manufacture and sell and this might be more generally tried, it costs very little.

Mr. POTTS : I do not think you could find a factory in Coventry where the chief designer had attained his position except by virtue of the fact that he had previously shewn his capabilities in the direction of workshop practice. This knowledge of workshop practice generally makes it possible to produce a job immediately. You also mentioned the qualifications of the executives. I think that

probably a good many firms are still suffering from the fact that the chief executives are their father's sons. I do really think that an executive council is the one and only institution to fully engender the team spirit which is so vital to thorough-going business.

Mr. YOUNG : In my experience I have suffered from the designer not knowing the first thing about machinery, and have not found works councils progressive.

Mr. SHAW : You get team work coming in when the designer evolves an idea, and puts it up to the sales engineer to see if it is going to conform to his ideas of what the public want. By the time you get them agreed, you begin to think you are getting somewhere near what is required. Speaking of leadership, I think there is nothing more despicable these days than a man not taking his responsibilities. Going to the question of salesmanship, I accept your version of that because I know you have travelled the world.

Mr. YOUNG : As far as leadership goes, I am not up against this, but I believe that a man who is a leader should be *the* man, and not a gang of people. You must have team work ; there must be somebody to take the lead, but unfortunately we have not got this in very many businesses.

Mr. AIERS : You mentioned about finding various commodities to make in the works. You spoke of one of the American sky-scrapers where so many tons of aluminium were used, and put forward that it was helping industry. I say that if aluminium was used to help the aluminium industry, surely the steel industry must have lost. Had it been a new product I should have agreed. In regard to nitraloys used in the crank ; cranks last a long time, and I should think it is cheaper to have the crank ground up again on the journals, rather than to go to the extra cost of having a nitraloy crank at the start. You mentioned chain stores and suggested it would be a good thing for industry if you could get them to use more transport on the roads, but I have heard that transport in the U.S.A. cities is very difficult, due to such a huge amount of traffic.

Mr. YOUNG : Generally speaking, the roads are not congested at all ; it is the foolish way people drive. In regard to aluminium, I am not concerned with what was made yesterday, and I say that we have got to look constantly to new materials, for instance, 400 tons of steel would not do what 400 tons of aluminium would do, and that is one reason for using it. Insofar as nitraloy crankshafts are concerned, I said the engineer has got to look to nitraloy as a new metal. When new metals come out, understand them, because as production men you know what happened when stainless steel came out, the suppliers had no knowledge of how to machine this for very many uses, especially if threading was necessary.

Discussion, Luton, Bedford, and District Section.

Mr. E. D. BALL : I would like to thank Mr. Young for his paper. He has covered the ground thoroughly except as regards the question of money. The financier seems to have too much control in industry. I think we are fairly efficient in all the matters he has covered but it seems we have been held up by financiers who do not understand the least bit about the technical problems we are up against and there is a tendency to regard finance as a thing in itself and not as it should be, the basis of industry. I should like to know if Mr. Young has any methods in mind whereby the financier can be more properly related to the technical side of our job—how we can stop him juggling in stocks and bonds until the industry is loaded with an impossible burden. In other words how we can keep the financier in control instead of letting him control us.

Mr. YOUNG : I am not a politician, money is not always intelligently controlled in small or large concerns. The question to me is why do we have to borrow money in business ? And how much actual money is there in business ? We have to borrow so we must pay back at the bank rates. Until business is back in the right way again we are dependent on banking. Money is inanimate and therefore has no influence on us. But we have influence on money. How many businesses have sufficient money to justify their own books ? I know of thousands of balance sheets for a million or five hundred pounds but you won't find the money. The cash in hand may be less than a thirtieth of the total assets. Industrial magnates may come to our assistance and loan us money at a much lower rate than the banks. I don't see how we can do much about it because in an analysis of business you will find that about eighty per cent. of our business in this country is controlled by a few people. There are several thousands of companies trying to live on the other twenty per cent. You have only to take boards of directors and see where they begin and end. Some people in these days believe they can be directors of several companies and are proud of the fact. They are not justifying their jobs. We have not much control of money in the present state of business.

Mr. R. BROOMHEAD : You have interested us very much this evening because you have taken us away from the general type of lecturer we have had here. We have been in the habit of coming here and talking about presswork tools and seeing how they are made and hearing all about what occurs in steel hardening etc., but to-night you have directed our attention to matters to which, in the past, we have paid very little attention.

A point to which little attention was paid was distribution costs, and it struck me why not do away with distribution costs and use advertising ? But a few minutes after you went on to justify

the existence of the sales engineer by quoting Ford and Chevrolet and told us also how the sales engineer had found what the public wanted. That seemed to be a good point and therefore before you finished I had to agree that sales engineering naturally followed.

Mr. YOUNG : You mentioned getting rid of distribution and going in for advertising. You would be in a sorry mess if you tried it. Advertising is part of distribution. Most articles that are sold require some explanation. It is the duty of the sales manager to get the advertising over to give his public the benefit of what he is trying to do. I am not in favour of cutting out advertising altogether but moderating it within limits as we have moderated our factory costs. Public demand is the very thing that must be studied. How to create public demand needs some imagination. When we were boys we seldom saw a wrist watch. The War made it necessary for people to know the time and the most convenient place to carry it was on the wrist so public demand was forced on us by necessity and it became a fashion and most people were adorned with a wrist watch. Therefore if you create a picture for your public to see they soon fall for it and anything that the imaginative sales manager can do is to the good. There are many products I could mention that have gone over big because the people have paid for the right kind of story. Take cosmetics, the third largest industry in the world. Women look much better than they used to but unless you put a story into the product they won't buy it. Our homes have changed since the War and will change more in future. In this country central heating and other things that we should think would be possible at low cost, are to-day looked upon as luxuries, as refrigerators are. There is a market here if we put a story into the thing right.

Mr. H. W. AULT : I should like to ask Mr. Young about material control. I hear that Germany can deliver, to Luton, if you like, pencils in two days—Great Britain takes three weeks. Whether that is control in the beginning, or distribution, I don't know. I think there are more than myself in this room who bear out the fact that if you try to deal with standard commodities you always have to wait.

Mr. YOUNG : Materials are nature's gifts and we have to recover them to make them into articles for sale or manufacture. Material control depends on how you handle it to get your materials. The question we have to consider is when the man wants the material and if possible to get it to him before. So far as Germany is concerned, Germany seems to have got a number of good scientists assisting industry who can get ahead on anything we can do. In Great Britain we have a number of very wonderful men, but their time is not used for developing industry and Germany is right ahead of us in these things. We realise the wonderful progress of the automobile industry in this country but we have to get the petrol

from Texas or somewhere else abroad. Go to Germany and they don't buy a penny-worth of foreign petrol. They manufacture their gasoline from coal. We should be doing the very same thing that Germany is doing. If we did we could employ about a hundred thousand more coal miners and we would not have to have what you call foreign petrol. We have to look at it as a nation and not be satisfied with what our grandfathers did, but go out on it ourselves and do the job. We could not produce the dyes that Germany did, because we believed that we were superior and must not be taught. We have to learn a lot and change our whole state, not only in material control. Should Russia put over her scheme we have got to begin again. The whole of Europe will have to sit up and take notice if Russia's scheme gets over for the whole schemes for generations will have been wrong.

Mr. E. LARSON : It would be interesting to know which you consider the most favourable and economical—an annual inventory or a running inventory. I have tried both and I am entirely in favour of a running inventory because you avoid that stoppage which is so costly.

Mr. YOUNG : I think a good many inventories are taken as a means of closing down and for the conserving of wages. I think that has been taken too much advantage of and if your system is worth anything you should be able to take a check immediately. If your card index is right you should be able to say " We have this in store, this in process and this is to be delivered by such-and-such a day." If you have a very large amount of material and a small amount of labour, you can count it all as material ; if you have a lot of labour and a small amount of material you have to consider it as labour. If you have operation sheets each operation can be costed. You can say " this article is worth so-and-so." If you have that and work to it I don't think that physical inventories should be taken so often. They are a great cost and something is wrong in the system if you take them very often.

Mr. LARSON : As to work in progress, I am with you. The system is such that that is shown immediately but I am referring to component part stores. One day you find that through a mistake something you think you have in stock you have not got. Furthermore, as I understand, the stock must be verified every twelve months.

MR. YOUNG : Taking costs through the store, it should not be much trouble for the store-keeper to keep records and check up every now and then. Most of us have bins in our store and often you find the wrong ticket is in front and if the store-keeper does not check up now and again no inventory is worth taking. It should be done every month. The finished stock bin should be a running inventory.

A vote of thanks to Mr. Young was adopted.

Discussion, London Section.

Mr. C. C. FERGUSON opened the discussion at the London Section, in which numerous members and visitors took part, Mr. YOUNG replying.

At the conclusion of the discussion a cordial vote of thanks to Mr. Young for his Paper was adopted unanimously.

THIRD ANNUAL MEETING AND SUPPER, LUTON, BEDFORD, AND DISTRICT SECTION.

THE third annual meeting and supper of the Luton, Bedford, and District Section of the Institution of Production Engineers was held on Wednesday at the Red Lion Hotel, Luton. The President, Mr. S. Carlton Smith presided, and at the top table were Mr. R. W. Bedford, Past President; Mr. E. W. Hancock, President of the Council; Mr. R. H. Hutchinson, Past President; Mr. A. J. Aiers, President, Coventry Section; Mr. R. Hazleton, General Secretary of the Institution; Mr. S. Gilbert; Mr. B. C. Jenkins; Mr. R. Broomhead; Mr. G. Erikson; Mr. J. Bullock; Mr. E. Swain, and Mr. S. B. Weller, with the Hon. Secretary of the Section, Mr. F. W. M. Lee. About sixty were present.

Considerable Progress.

MR. CARLTON SMITH said that during the past session the series of lectures had been very well attended and very successful. The section had made considerable progress. There were now about fifty-eight members. They had a quota which had to be made up during the session. The President was sure they would do it.—(Hear, hear). He had had great support from the committee, which he very much appreciated.

The President having retired from the chair, MR. R. W. BEDFORD said Mr. Carlton Smith had been a remarkably good president, and had had the interests of the Section and of the Institution at heart during the whole of the year. The committee felt they could not do better than ask him to stand again. According to the constitution, a president could serve for not more than two successive years, and the section was going to have its whack.—(Hear, hear).

The President welcomed the President of the Council, Mr. Hancock, and Mr. Hutchinson and representatives of nearly every important engineering industry in Luton and district. The President then announced the re-election of the three retiring members of the committee, Messrs. R. W. Bedford, W. M. Pudge, and J. Ronald. There were two new names for the committee, Mr. A. R. Wright and Mr. S. Gilbert, who were also elected.

Existence Justified.

MR. R. BROOMHEAD, proposing the toast of the Institution, asserted that the Institution had justified its existence. He recalled the support of famous people, and coupled with those names that of Sir Walter Kent.—(Hear, hear). Because he believed that it was due to his sympathy with Mr. Bedford that the Section made such good progress. Mr. Broomhead mentioned that in October, 1931, the

March 23rd. Luton News Report.

Institution constituted 652 members. The Luton Section then numbered 50. They were given a quota of ten with ten graduates. There was a bit of a hitch about the graduates, due to the educational system in Luton, which they hoped some day would be put right. One of the chief objects of the Institution was to raise the status of the production engineer. Mr. Broomhead reviewed the lectures of the past season, by which they learned things they should know, and which they could not otherwise find out, because they were tied to their own jobs.

Wide Field.

MR. R. H. HUTCHINSON said the activity of the Institution would become of greatest importance to the nation. The raising of the status did not just mean making a few individuals appear more important, but to raise the appreciation of the public of what was meant by a production engineer. Production engineering meant the whole phase of production from the winning of the raw material—quarrying, mining, or growing—right through its stages of refining conversion into workable stock, machining, and the finishing of the article ready to turn over to the salesman. That field took in mining engineers, metallurgists, steel work engineers, machinists, designers, and tool manufacture. The Institution was developing, and anticipated being a thousand strong this year, because they were necessary to the industry they represented. The Luton Section was looked upon as a bright spot in the organisation, because it was typical of the great difference there was between the Institution and the other three great institutions—the Civils, the Mechanicals, and the Electricals. Each of those covered a great profession, but he could not conceive any of those three being able to have a branch in a place like Luton. But the Institution fitted in, and it would grow to be a great power in the land.

Mr. Hutchinson also referred to the Institution's development in the graduate section of membership. Through it they hoped that they would soon be able to send their sons to college to learn production engineering.

MR. R. W. BEDFORD called the health of the guests. He said that he felt that the branch's justification of its existence was proved by the presence of the President of the Council and the Secretary.

MR. A. J. AIERS, responding, said he complimented the Luton and Bedford branch on its progress, and urged them to press the educational authorities to put into operation a production engineers' course.

THE PRESIDENT explained that Luton did not control its own higher education scheme, and they had to go to Bedford.

Entertainment was given by Miss Linda Love and Miss Frances Weatherley, of London. During the evening the golden wedding of Sir Walter Kent was referred to.